MINING
DIGEST

L. C. Kaku

MINING DIGEST

A Guide for Overman's Competency Examination Recruitment Tests of CIL, SAIL, Singareni and other Coal Companies & Orientation Training of Workmen's Inspectors

Containing

- Q & A subject-wise including Overman's Exam questions
- Question papers: Overman's Exam
- Bye-laws & New Syllabus
- Recruitment Tests of CIL, SAIL, Singareni and other Coal Companies : Q & A
- Multiple Choice / Objective type questions & answers

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Useful for written & oral examinations

By

L.C. KAKU

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According to New Syllabus

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If you have a suggestion for improvement of the book, do email it to *lckaku@gmail.com.*

—L.C. Kaku

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SECTION - A

Questions and Answers Subjectwise

Including

Overman's Examination Questions

Chapter 1

DUTIES AND RESPONSIBILITIES OF OVERMAN, OFFICIALS AND COMPETENT PERSONS

Any person aspiring to become an overman must have a **clear idea** of duties and responsibilities of overman. In order to enable you to have a thorough grasp, the subject is discussed below in various ways. First the entire Regulation 43, duties and responsibilities of overman, is quoted. Then a diagramatic analysis is given in a sort of a flow chart. This is followed by a short simple write-up which you can use for answering a question in the examination. And finally some smaller questions and answers are given to bring out finer points or to emphasize certain aspects—for example difference in duties of overman and mining sirdar. This is logically followed by subjects of an overman's report.

DGMS officials conducting the examination attach much importance to this subject—because obviously a man cannot do his job if he does not understand what he is expected to do.

At first reading, if the subject appears a bit complicated, don't worry. Just go through it, read the balance pages of the book, and then come back to this chapter.

Please note that this chapter is important from all points of view.

With these words, let us proceed.

Reg. 43. Duties and responsibilities of overman—The overman shall strictly observe the following provisions namely—

(1) (a) Subject to the orders of superior officials, he shall have responsible charge and control of such part of the mine, and shall carry out such duties, as may be assigned to him by the manager.

(b) While on duty, he shall carry a tracing of the workings of such district and shall **keep the tracing up-to-date.**

(c) He shall make inspections in his district and write reports required by these regulations.

(d) He shall be responsible to see that subordinate officials and competent persons in his district carry out their respective duties in a proper manner.

(e) He shall, to the best of his power, **enforce** in his district the provisions of the Act, regulations and orders made thereunder, and shall, subject to the control of the manager and the undermanager or assistant manager, give such directions as may be necessary to ensure compliance with those provisions, and to secure safety of the district and the safety and proper discipline of persons employed therein.

(2) He shall see that sufficient supplies of timber, brattice and other necessaries required for safe working of his district are kept in **convenient places therein**.

(3) (a) He shall see that every air-crossing, stopping, door, brattice and other ventilation device is maintained in good order.

(b) He shall, in his district, see that ventilation is effective; and when brattices or air pipes are required to be used for ventilation of the working places, he shall see that they are **kept sufficiently advanced** to ensure that an adequate amount of air reaches every such working place.

(c) He shall have power to **send out of the mine** any person under his charge infringing or attempting to infringe any provision of the Act or of the regulations or orders made thereunder, or failing to carry out any direction given with regard to safety; and shall report in writing any such infringement or attempted infringement or failure to the manager.

(4) (a) He shall see that all tracks and tramlines are properly laid, graded, ballasted or otherwise packed.

(b) He shall see that **manholes** on haulage roadways are kept safe, clear of any obstruction, and properly whitewashed.

(c) He shall see that stop-blocks, runaway switches and other safety devices are fixed, used as required under the regulations, that drags or back-stays are provided and regularly used behind tubs ascending incline and that a sufficient supply of suitable sprags is provided where tubs are loaded on a gradient or lowered on a gradient by hand.

(d) He shall, if he finds any of the ropes, chains, signals, brakes, jig wheels and posts or other apparatus in use in his district to be in an unsafe condition, stop use of the same **forthwith.**

(5) He shall be responsible to see that except for the purpose of inspection, examination and repairs, every person other than an official or a haulage attendant **travels by the travelling roadway.**

(6) He shall give prompt attention to the removal of any danger observed or reported to him and shall see that dangerous places are **adequately fenced off.**

(7) He shall, under the direction of the manager, see that approved safety lamps are used and naked lights excluded wherever and whenever danger from inflammable gas is apprehended.

(8) (a) He shall devote the whole of his time to his duties and visit each working place in his district as often **as may be necessary or possible.**

(b) He shall not, except for a **justifiable cause,** leave the district in his charge until he has finished the inspection required under these regulations and any other duties that he is required to perform, or until relieved by a duly appointed substitute.

(c) He shall, if the mine is working in a continuous succession of shifts, confer with the official succeeding him and give him such information as may be necessary for the safety of his district and of persons employed therein.

(9) He shall, at the end of his shift, record in a bound-paged book kept for the purpose a general report on the performance of all his duties during the shift, including

anything concerning the proper working of the mine and the safety and discipline of persons employed in his district.

Now let us analyse the above provisions.

Reg. 43. Duties and Responsibilities of Overman—Overman shall have *responsible charge and control* of district, carry out *duties assigned* by the manager and make *inspections & reports* required by the Regulations.

(He shall carry a tracing of his district and keep it up-dated.)

To ensure in his distt.

1. Proper Working
2. Safety
3. Discipline

the Overman shall
- enforce provisions of Regulations
- implement directives of Manager & Asstt./Under manager
- keep control over men

For this he shall
- A. Monitor work of (1) officials, (2) competent persons
- B. Give directions
- C. Make inspections (visit each working place as often as necessary)

to particulary check that
1. **Supplies** (timber, brattice, stemming material etc.) are kept in convenient places.
2. **Ventilation**—devices are maintained in good order
   - is adequate (brattices/air pipes are extended to 4.5m of faces)

   (safety lamps are used by mining sirdars/ shotfirers and competent persons)
3. **Haulage**—tracks & tramlines are properly laid, graded, ballasted.
   - manholes are kept safe, clear, white washed.
   - safety devices are provided & used, sufficient sprags are kept available.
   - stop use if any ropes, chains, signals, brakes etc. are unsafe.
4. Men travel by **Travelling Roadway** only.
5. **Danger** (observed or reported) is
   - removed promptly
   - place adequately fenced off.
6. **Discipline** is maintained. Person violating rules/ disobeying may be sent out.
7. **Working places** are safe; supports are set as per Systematic Support Rules.

   Inspections shall be made as often as required or possible.

- D. At end of the shift
  - Confer with overman of incoming shift
  - Write report

A simplified write up

Duties and Responsibilities of Overman

The overman shall have responsible charge and control of his district, carry out duties assigned by the manager, and make inspections and write reports required by the regulations. He shall carry a tracing of the district under his charge and keep it up-dated.

To ensure proper working, safety and discipline, he shall

- ▪ enforce provisions of Regulations
- ▪ implement directives of manager and senior officials, and
- ▪ keep control over men.

For this, he shall—

A. Monitor work of (1) officials, (2) competent persons.

B. Give necessary directions.

C. Make inspections, particularly to check that :

1. **Supplies** (timber, brattice, stemming materials, roof bolts etc.) are *sufficient* and kept in *convenient places*.
2. **Ventilation** devices are maintained in good order, ventilation is adequate (brattices/air pipes are extended to 4.5m of faces),

safety lamps are used by mining sirdars/shotfirers and competent persons,
there is no accumulation of gas in the workings.

3. **Haulage**
   - tracks and tramlines are properly laid, graded, ballasted,
   - manholes are kept safe, clear, white washed,
   - safety devices are provided and used; sufficient sprags are kept available,
   - stop use if any rope, chain, signal, brake etc. is unsafe.
4. Men travel by **Travelling Roadway** only.
5. **Danger** (observed or reported) is
   - – removed promptly, and
   - – the place fenced off adequately.
6. **Discipline** is maintained. Person violating rules/disobeying may be sent out of the mine.
7. **Working places** are safe; supports are set as per Systematic Support Rules.

   He shall make inspections as often as required or possible and shall spend whole of his shift on his work.

D. At end of the shift, he shall

- Confer with overman of the incoming shift, and
- Write a report regarding work, safety and discipline.

Questions and Answers

Q. 1. What type of inspections have to be carried out by overman, holding charge of a district?

Seven types of inspections by Overman of district

1. Inspection to see that stock of **safety materials** (timber, brattice cloth, ducting, stemming material, roof bolts, sprags etc.) is *sufficient* and kept at *convenient places* in the district.
2. Inspection of **ventilation devices** (doors, stoppings, air crossings, brattices, air pipes etc.) to ensure adequacy of ventilation in every working place.

3. (a) Inspection of **haulage track** to see that it is properly laid, graded, ballasted, and safety devices (stop block, runaway switch, drag, sprags etc.) are in *order and used regularly.*

   (b) Inspection of haulage rope, chains, pulleys, signals etc.
4. Inspections to ensure that men travel by Travelling Roadway only.
5. Inspections to check **dangerous places.**
6. Inspections to ensure that **officials and competent persons** are discharging their duties properly, and to maintain discipline (this includes use of flame safety lamps by mining sirdars/shotfirers and other competent persons.)
7. Inspection of **working places** as often as necessary or possible; he shall particularly check whether supports have been set as per Systematic Support Rules. If two faces have reached within 10m, he shall give necessary instructions to mining sirdar and shotfirer.

Q. 2. When can overman leave the district under his charge?

During his shift an overman can leave the district only for a 'justifiable cause' i.e. when it is absolutely necessary for carrying out his duties as per the regulations.

Otherwise, he shall not leave the district in his charge—

(a) until he has finished the inspections required under the regulations and any other duties that he is required to perform, or

(b) until relieved by a duly appointed substitute.

Q. 3. What is an overman's duty in respect of haulage roadways?

Overman's duties for haulage roadways

To see that :

(a) all tracks and tramlines are properly laid, graded, and ballasted,

(b) manholes are kept safe, clear of any obstruction, and properly whitewashed,

(c) stop-blocks, runaway switches and other safety devices are fixed and used as required under the regulations, drags are provided and regularly used behind tubs ascending incline, and a sufficient supply of suitable sprags is provided where tubs are loaded on a gradient or lowered on a gradient by hand,

(d) ropes, chains, signals, brakes, jig wheels and posts or other apparatus are in safe condition; if anything is unsafe, he shall stop the use of the same forthwith,

(e) no person travels by the haulage roadway, except for the purpose of inspection, examination or repair,

(f) the points of coupling and uncoupling are well lighted,

(g) trammers, loosemen etc. are working in a safe manner,

If there is a derailment, he shall note the place, find out the cause and take corrective action.

Q. 4. What is the difference in duties of mining sirdar and overman in respect of dangerous places?

If mining sirdar finds any place in the district dangerous, he shall immediately (i) withdraw people to safety, (ii) fence off the place, (iii) intimate the overman to get directions regarding actions to be taken to remove the danger.

Overman shall inspect the dangerous place, and issue directions/take action to remove the danger.

Q. 5. When does an overman's certificate become invalid?

An overman's certificate (and gas testing certificate) becomes invalid when it is due for 5 yearly endorsement for medical fitness but the endorsement has not been done.

As per the regulations, overman's (sirdar's and gas testing) certificate shall not remain valid for a period of more than 5 years unless the certificate bears an endorsement by the Regional Inspector to the effect that the holder has within the preceding 5 years, been examined by a qualified medical practitioner appointed by the Chief Inspector to be free from deafness, defective vision or any other infirmity, mental or physical, likely to interfere with the efficient discharge of his duties.

A medical examination under Rule 29B of Mines Rules, 1955 (periodical medical examination) shall also be deemed to be an examination for the above purpose.

Q. 6. In what capacity can an overman be employed in a mine?

Capacity in which overman can be employed

1. As incharge of a mine or district
2. As dust incharge, sampling incharge or dust-cum-sampling incharge.
3. As training instructor.
4. As incharge of
   - (i) weekly examination of shafts, inclines and other outlets.
   - (ii) weekly examination of haulage and travelling roads, including roadways leading to mine outlets in use.
   - (iii) any work of dealing with or sealing off a fire or heating.
   - (iv) weekly examination of isolation stoppings erected to control a fire or spontaneous heating underground.
   - (v) fortnightly examination of ventilation devices.
   - (vi) first inspection of

     a mine or part which is re-opened after a discontinuance of mining operations for a period of more than 7 days.

     any part of the mine after being dewatered.
   - (vii) weekly examination of unused workings, which have not been sealed off, for presence of inflammable gas and noxious gases.
   - (viii) checking of Transit Slips to prevent pilferage of explosives.
   - (ix) bulk transport of explosives in opencast mine.
   - (x) blasting in opencast mine.
   - (xi) fortnightly inspection of protective measures against danger from surface water, for their stability.
5. As chargeman of sinking shaft.
6. As shotfirer where solid blasting is done.

Note : Overman can be nominated as Workmen's Inspector. This list need not be remembered by the candidate. It is for his awareness to see that he has the knowledge and ability to carry out these works.

Q. 7. Under which regulation is overman incharge of a district appointed? What should be the size of an overman's district?

Overman incharge of a district is appointed under Reg. 34 of Coal Mines Regulations 1957.

The size of an overman's district should be such that, considering other duties assigned to him, he shall be able to carry out his prescribed duties in a thorough manner. He shall not be burdened with such additional duties as may prevent him from doing his prescribed duties in a thorough manner.

> **Reg. 34 Appointment and qualifications of senior officials**—(1) At every mine one or more overmen shall be appointed to hold charge of different districts of the mine on each working shift.
>
> (1A) The district assigned to an overman under sub-regulation (1) shall not be of such a size, nor shall any additional duties other than his duties under these regulations be such as are likely to prevent him from carrying out in a thorough manner the duties prescribed for him under these regulations, and in case any doubt arises as to the foregoing duties, it shall be referred to the Chief Inspector for decision.

Note : Overman is appointed under Reg. 34 and his duties and responsibilities are given in Reg. 43. (easy to remember)

Q. 8. On what subjects does the overman of an underground mine write a report at the end of his shift?

Subjects of overman's report

Overman's report book is generally a printed book. It is a bound book and the *pages are serially numbered.* (that is why it is called **bound-paged book**) After filling up details like name of mine, seam, district, date/time of inspection, and parts visited, he writes a report on the following topics (A to M) :

A. *Safety materials*

Supply made during the shift and whether the stock u.g. is adequate. Materials required.

B. *Ventilation and inflammable gas*

- Ventilation appliances—condition, any deficiency
- Any stopping, brattice or air pipe lagging behind (give particulars)
- Any re-circulation of air by auxiliary fan
- Deficiency in use of safety lamp by mining sirdars/shotfirers / other competent persons
- % of inflammable gas detected, name of face, action taken

C. *Haulage*

- Safety devices and appliances—condition/deficiency
- Any derailment of tubs—place and cause of derailment
- Any persons found travelling by haulage road—action taken

D. *Danger*

Any danger observed—action taken, fenced or not.

E. *Support*

- Deficiency noted in the support of freshly exposed roof or depillaring district.
- Name of stook from which supports were withdrawn.

F. *Handplan*

Up-dated

G. *Faces within 10m of each other*

Instructions issued to mining sirdar & shotfirer

H. *Abnormal seepage of water*

Give details

I. *Persons sent out of the mine*

Name, reason

j. *Safety directions*

Directions given

K. *Conference with successor*

Give details

L. *Any accident*

Place, cause and other details. First aid given by—

M. *Any other information or remarks*

Give a descriptive report.

At the end, the overman signs the report giving date and time.

Note : A sample of Overman's Report can be seen in the pages ahead.

Q. 9. Define 'Overman'.

Overman

'Overman' means a person possessing a *Manager's or Overman's* Certificate, who is appointed by the manager in writing, under *any designation* whatsoever, to perform the duties of supervision or control in a mine or part thereof and is as such superior to a sirdar. [Reg. 2 (22)]

Note : Second class manager's certificate holder can also be appointed as an overman in a very complicated highly mechanised mine. In smaller mines there may be only one overman. In bigger mines, an overman may be appointed for a part of the mine or district. The boundaries of district assigned to the overman are marked in the tracing of workings given to him. As noted in the definition above, an overman performs the duties of supervision and control.

Q. 10. Assuming your own conditions, write an overman's report after inspection of a depillaring district worked by open caving method. (1995)*

Overman's Report

Central Coalfields Ltd.
OVERMAN'S DAILY REPORT
[Reg. 43 (9) of CMR 1957]

I, the undersigned, being a person duly appointed and authorised as required by Reg. 34, hereby declare that I have carefully examined the workings named below, which are under my charge and control, and have to report as follows :

Sayal D Colliery
District : 28 W depillaring panel — Semana Seam
Date : 10.6.2015 — Shift I
Places inspected : Haulage incline, 28WL belt road, all faces of 28 W Panel.

---

* The year of Overman's Competency Examination

A. *Safety materials*

	Supplied during the shift	*Adequacy of stock u.g.*
Timber	25 props (3.6m)	OK
Brattice	Nil	OK
Sprags	Nil	OK

B. *Ventilation & inflammable gas*

	Condition	*deficiency*
■ Ventilation appliances	OK	—
■ Brattices	OK	—

- Lag of stoppings/air pipes : None
- Re-circulation of aux. fan : Not applicable
- Use of safety lamps by sirdar, shotfirer, competent persons : OK
- Any gas detected : No
- Working places where ventilation was found inadequate: None

C. *Haulage*

Haulage incline	*Condition*	*any deficiency*
1. Safety devices		
■ Stopblock	Working	—
■ Runaway switch	Working	—
■ Drags	OK, used	—
■ Manholes	all clear, safe	—
■ Rerailers	Provided	—
2. Signalling	OK	
3. Lighting	Adequate	
4. Ropes, chains, signals, brake	Safe	

5. Tracks/ Tram lines : Haulage Track between 8 WL and 9 WL needs to be regraded. General shift overman Sri N.K. Swamy has been informed.
6. Derailment : None
7. Persons found travelling by haulage road : None

D. *Danger observed* : Nil

E. *Support*

Deficiency : Nil

Withdrawal of supports : support withdrawn from Ist slice of 4 $^{1/2}$ L of 8th dip (pillar no. 10); goaf edge supports have been completed, tightened.

F. *Handplan* : Updated

G. *Any workings approaching within 10m of each other : None*

H. *Abnormal seepage of water :* nil

I. *Persons sent out of the mine :* none

J. *Directions given for safety / discipline* : Closer inspection, gas testing, dressing and support of freshly exposed roof required in the main dip face; minor slips seen, face approaching 3m downthrow fault.

K. *Information to successor* : Main dip face is approaching 3 m downthrow fault; in 28W depillaring panel goaf noises have started—conditions require careful watch.

L. *Accident and First-aid* : No Accident

M. *Remarks :* Timber withdrawn may be stacked away to provide free escape route.

Descriptive Report : Minor slips have been observed in the main dip face on east side, face is approaching 3m fault shown in the handplan; face has been cleared for cut.

I hereby certify that I have written the above report after making thorough examination.

10.6. 2015
4.15 P.M.

Signature
Overman

Q. 11. Define 'official' and 'competent person'. (1992, 1998)

Official and Competent Person

Official means a person appointed in writing by the owner, agent or manager to perform the duties of supervision in the mine/part of the mine. It includes Mining Sirdar, Overman, Assistant Manager, Under Manager, Ventilation Officer, Safety Officer, Engineer, Dust Incharge, Sampling Incharge, Surveyor.

Competent person, for any work or any machinery, means a person—

- Of 20 years or more duly appointed in writing by the manager as person competent (1) to supervise or (2) to perform that work, or (3) to supervise the operation of that machinery/plant/equipment and,
- Who is responsibile for duties assigned to him.
- It includes a shotfirer.

Example : Driller, Dresser, Haulage *Khalasi*, Pump *Khalasi*, Fitter, Electrician, Banksman, Onsetter, Belt Conveyor Operator, Shovel Operator, Dumper Operator, Lamp Room incharge, Attendance Clerk, Body Searcher, Competent Person for quarterly examination of fire extinguishers, Competent Person for weekly examination of haulage tracks, Shotfirer.

Note : How does the manager 'duly appoint' a competent person? He explains the duties to the person, hands over a copy of the rules/regulations concerning his work, and gets his signature or thumb impression to that effect by issuing what is commonly known as 'authorisation'. The manager retains a copy of authorisation as a proof.

In some mines the manager hands over to officials a copy of Coal Mines Regulations where he thinks fit to do so.

Note this difference :

Official is for duties of supervision of mine/part of mine.

Competent person is for,

(a) Operating a machine, or
(b) Doing a work, or
(c) Supervising a work or machine.

Q. 12. What are the duties of officials?

Duties of officials

(1) To carry out duties

- assigned to him by the Manager, U.M. or Asstt. Manager
- as per the Act, Regulations etc.

(2) To the best of his power, to see that persons under his charge

- understand and

- carry out
- their respective duties properly.

Q. 13. What are the duties of a competent person?

Duties of competent persons

(1) To carry out duties obeying orders of superior officials,

(2) not to depute another person to perform his work without approval of superior official,

(3) not to perform duties other them those alloted to him,

(4) not to absent without prior permission, or without having been relieved by a competent person.

Q. 14. Describe the duties and responsibilities of mining sirdar. (2011)

Duties and responsibilities of mining sirder

1. ■ Mining sirdar shall obey orders of superior officials.
   - Keep control on work in the district assigned to him.
   - Make all efforts to ensure observance of the Act, regulations and orders issued thereunder.
   - If anyone contravenes the provisions, he shall inform the overman immediately.
   - He shall carry out all inspections required by the Regulations and write report.

2. In beginning of the shift,

(a) He shall take charge from mining sirdar of the previous shift underground.

(b) If the mine is not worked in succession of shifts, he shall, within 2 hours before commencement of work in the shift, inspect all working places and roadways where persons have to work or pass during the shift.

During the inspection, he shall be accompanied by such assistants as may be necessary, and shall ascertain the condition regarding—

(1) ventilation

(2) sanitation

(3) presence of gases

(4) state of roof and sides

(5) presence of spontaneous heating and other fire risks

(6) generally for safety of persons.

The inspection shall be made with the help of approved flame safety lamp, in case of a fiery seam also with a cage containing suitable birds or an approved CO detector. He shall pay particular attention to (1) checking of supports, (2) goaf edges, and (3) presence of gases.

After the above inspection, he shall go to the 'station', allot working places to the workmen waiting there and advise about any special precautions to be taken by them.

3. Inspection during the shift

Inpections similar to the above shall be carried out at least once in every 4 hours. He shall see that workmen are doing their job carefully. If he finds any workman at a place where he is not authorised to go, he may order him to leave the mine, and inform the overman.

4. Support

- The mining sirdar shall arrange to dress and support roof and sides of all working places and roadways to make them safe.
- He shall observe systematic support rules strictly.
- Make sure that no support is withdrawn without a safety prop withdrawer. He shall ensure availability of sylvester machine, chain and rope for the purpose.
- Ensure availability of bunton (of adequate length) and ladder, if height at any place is more than 3m.

5. Precautions against dangers

(a) If he finds any place unsafe or gets report of a danger which cannot be removed immediately, he shall

- withdraw the persons from such place,
- not leave the place until the danger is removed, or the place is fenced off.

(b) He shall take care that any dangerous work is done with due precautions, and shall be present throughout whenever any work of clearing of falls of ground and setting of supports therein is being carried out.

(c) He shall arrange to fence off entries to places not being worked or used.

(d) If he finds an accumulation of inflammable or noxious gases, he shall withdraw all person from the place, fence it off and report the matter to the superior official. He shall not attempt to remove the danger without his instruction.

(e) Report to the overman any deficiency of air.

6. In case of an accident

On receiving information of accident in the district, he shall reach there immediately.

- inspect the place,
- if required, supervise rescue operations, and
- report or send information of accident to the overman, manager, assistant manager.

7. Inspection of second outlet

If any of the two exit routes to surface is not ordinarily used for travelling, he shall travel the whole such way, at least once in every 7 days to remain acquainted with the same.

8. Charge handing over and writing of report

He shall devote the whole of his time to duties, and shall not leave the mine without handing over charge to mining sirdar of the succeeding shift, in the district. He shall also write a descriptive report of his shift.

Q. 15. How overman's work differs from that of a mining sirdar?

Difference in duties of mining sirdar and overman

Mining Sirdar	Overman
1. Responsible for only one district assigned ro him.	1. Overman is responsible for the entire mine. He oversees the work of mining sirdar and shotfirer.
2. Ensures safety of persons in the district and compliance of law by them.	2. Along with ensuring compliance with the statute, he also looks after discipline in the district. He is representative of the manager.
3. In case of deficiency of materials, he informs the overman.	3. He arranges to get the materials.
4. He is directly responsible for dressing and support of roof and sides.	4. He is indirectly responsible for dressing and support.
5. He is not responsible for haulage and ventilation, In case of deficiency of ventilation, he withdraws men to safety.	5. He is responsible for haulage safety appliances and ventilation.
6. In case of danger (from gas, fire, water), he withdraws persons, fences off the place and informs the overman. He does not attempt to remove gas accumulation without directions from the overman.	6. Overman arranges to deal with the danger; gives directions to mining sirdar.
7. Not statutorily necessary to keep a tracing of the district with him.	7. Keeps overman's handplan always with him. He ensures that workings advance as per the layout, and depillaring is done in correct sequence. He keeps an eye on possible dangers like faults, slips.
8. In case of accident, he arranges rescue, first aid of the injured and fences off the site of accident.	8. He tries to find out cause of the accident also.
9. Cannot be authorised as manager.	9. In small mine, in absence of manager (and assistant. under manager), he can be temporarily authorised to act as manager.

Q. 16. Describe duties and responsibilities of shot-firer. (2002)
What are his duties at the end of his shift? (2010)

Duties and responsibilities of shot-firer

(a) To carry out his duties in accordance with the provisions of the regulations and orders issued thereunder with respect to transport and use of explosives;

(b) be responsible for the observance, by his assistants, of such provisions and of any directions given by a superior official for safety;

(c) not to hand over any explosives to any unauthorised person;

(d) see that clay, sand or other suitable stemming material is available in sufficient quantity at convenient places;

(e) be present when shots are being charged and stemmed; and shall himself fire the shots; and

(f) be responsible, when a shot has misfired, for seeing that the place in adequately fenced, and that the provisions of Reg. 177 are strictly followed.

Duties of shotfirer at end of the shift

Immediately after the end of his shift, the shotfirer :

(a) shall return unused explosives to the magazine (or if u.g. store is provided as per the regulations, to such store).

(b) shall record, in a bound paged book kept for the purpose, the quantity of explosives taken, used and returned, the places where shots were fired and the number of shots fired by him, and misfires if any. He shall sign and date every entry.

Q. 17. Describe the duties of :

(a) Haulage attendant (1975, 1978, 1992, 2011)

(b) Onsetter (1992)

(c) Attendant of main mechanical ventilator (1978, 1980, 2006, 2011)

Duties of haulage attendant (haulage khalasi)

1. At the beginning of his shift, he shall examine the engine, its brake and all appliances in his charge, and shall satisfy himself that they are in good working order.
2. He shall keep the haulage engine etc. properly cleaned and oiled, and haulage-room clean and free of inflammable material.
3. If there is any defect in the engine, brake, drum, rope, signalling arrangement etc., he shall report immediately to the engineer or other competent person appointed for the purpose.

4. He shall run the engine carefully and without jerks and reduce the speed at curves etc.
5. He shall thoroughly acquaint himself with and carefully attend to the code of signals. He shall not start the engine until he has received proper signal to do so. If the signal is indistinct, he shall not start the engine until it has been repeated and he clearly understands it.
6. Whenever he has to leave the engine, he shall cut off the power and apply the brake.
7. He shall not allow any unauthorised person to enter the engine room or to interfere with engine, signal etc.
8. He shall keep a safety lamp burning at a proper place so that in the event of power shutdown, he gets some light to apply brakes etc.

Duties of onsetter

1. *Control*. He shall exercise full control at the shaft bottom (or the inset). If any person disobeys his instructions or gives a signal, he shall report the matter to his superior official.

2. *Signalling*. He shall acquaint himself with the code of signalling, shall attend to signals carefully and transmit signals carefully by means provided.

   He shall not act on doubtful signals, except a signal which he believes to be 'to stop'.

   He shall not allow any unauthorised person to give signals.

   If there is any defect in the signalling device, he shall report to his superior official.

3. *Constant attendance*. Onsetter shall devote the whole of his time to his duties and remain at his post all along. At end of the shift, he shall not leave his post unless all persons have come out of the shaft or unless he has been relieved by a duly appointed substitute.

4. *Manwinding*

   (i) He shall not allow more than authorised number of persons to enter the cage.

   (ii) He shall not allow any person to carry with him bulky materials other than his tools and instruments.

(iii) After any stoppage of winding for repairs etc. for more than 2 hours, he shall run the cage atleast one trip up and down before allowing any person to enter the cage.

(iv) He shall not allow any person to ride on top or edge of the cage (except when engaged in examination, repair or other work in the shaft).

(v) After persons have entered the cage, he shall see that cage gates on both sides are in position and closed, before signalling for movement of cage.

5. *Material winding.* He shall not allow any unauthorised person to handle tubs in or out of the cage. He shall see that catches are holding the tubs properly before signalling the cage away. If he notices any defect in tub-catches, he shall immediately inform his superior official.
6. *Cage gate.* He shall not begin to remove the fence or gate until the cage has stopped, and shall close it before signalling the cage away. He shall not permit any unauthorised person to open or interfere with the gate.
7. He shall keep the floor of every cage free from loose materials.

Duties of attendant of main mechanical ventilator

(a) To keep ventilator running at the speed fixed by the manager, and not stop it without his written authority.

(b) To examine the machinery and observe the pressure recording or water gauge and the speed indicator

- at intervals of not more than one hour, and
- enter the readings in a bound-paged book kept for the purpose at fan-house.

(c) To immediately report to his superior official

- any stoppage of,
- damage to, or
- defect or derrangement in the machinery, or
- any unusual variation in water-gauge or other indicators,
- any unusual circumstances in regard to mine ventilation which come to his notice,

(d) Not to leave his post until relieved by a duly appointed substitute.

Q.18 Write the duties of the following:

(a) Lamp room incharge (2006, 2008)
(b) Dust incharge (2006)
(c) Supportsman (2010)
(d) Workmen's inspector (2000)
(e) Welfare officer (2006)

Duties of lamp room incharge

1. To ensure that all lamps in the lamp room are maintained properly as per the regulations.
2. To see that lamp room is kept in a neat and tidy condition.
3. To see that damaged and defective gauges, glasses and other parts of safety lamp are not kept or stored in the lamp room.
4. To see that fire extinguishers or other means of dealing with fire provided in lamp room are in good condition and readily available for use.
5. To ensure proper maintenance of record of issue, return and maintenance of lamps.
6. To carry out other duties given by manager or under manager or assistant manager regarding maintenance and issue/return of lamps.

Duties of dust incharge

1. To get Dust Plan made by the surveyor (scale 1:2000) showing-

   Areas naturally wet
   Areas requiring stonedusting at 24 hours, 7/14/30 days/3 months' interval
   Areas requiring treatment with water.

   Keeping the plan updated.
2. To mark the above zones u.g. by hanging number plates.
3. To ensure proper stonedusting in areas required to be stonedusted.

   Dust on floor/roof/sides/supports/structures should always contain not less than 75% of incombustible matter. If volatile matter of coal is more than 30%, incombustible content shall be not less than 85%.

Before spreading stonedust, all coal dust shall be cleaned and removed to surface within 24 hours.

4. To ensure proper water spraying in areas to be treated with water.

   Dust on floor/roof/sides/supports/structures shall always contain not less than 30% of water in intimate mixture.

   Dust incharge shall see that within 90m of the face, spraying is done before firing shots and at suitable intervals during working hours.

5. To remove periodically layer of coal dust deposited on stonedust of dust barrier. To change the dust when it becomes indispersable or contains much coal dust.
6. To see that adequate stock of stonedust is maintained in convenient dry places u.g. To report to Ventilation Officer/Manager in case of shortage.
7. To send 3 monthly samples of stonedust received for analysis.
8. To see that pipelines for water spraying are kept maintained and extended.
9. To keep a daily record of areas cleaned, dusted or treated with water. To sign and put up the same to V.O/Manager for counter signature.

Duties of supportsman

1. The supportsman shall carry out orders of the manager or assistant manager, overman, *sirdar* or other competent person with respect to securing of roof and sides.
2. He shall ensure placement of supports strictly in accordance to the support plan.
3. He shall report to the *sirdar* or other competent person, any shortage of support material in the district.
4. In case of use of timber, he shall be responsible to see that wood cuttings are not left in any working belowground.

Duties of workmen's inspector

1. To inspect all shafts, inclines, roads, work places and the equipment thereat including equipment for manriding.
2. In case of any urgent danger that comes to his notice,
   - To inform the manager and the inspector,

   - To suggest remedial measures.
3. To accompany the inspector during complete inspection of the mine and also in other inspections if considered necessary by the inspector.
4. To write a report of his inspections in Form U register and sign giving date.

Duties of welfare officer

1. To establish contacts and hold consultations with workers to maintain harmonious relations between management and workers.
2. To bring to the notice of management grievances of workers.
3. To promote relations between management and employees for better productivity and efficiency, and amelioration in working conditions. To help workers to adjust and adapt themselves to the working environment.
4. To assist in formation of production committee, cooperative society, welfare committee & housing committee and to supervise their work.
5. To help management to regulate grant of leave, to help the workers in applying for leave.
6. To advise management on welfare measures (housing facilities, canteens, social and recreational facilities, sanitation, education of children, etc.).
7. To supervise statutory and other welfare activities for employees.
8. To help raise the standards of living of workers and to promote their wellbeing.
9. To perform any other duty relating to welfare of workers.

Welfare officer shall not involve himself in disciplinary action against any workman. But, he may appear before the conciliation officer, court or tribunal if required by them. He shall keep a record of his day-to-day work.

Note : For duties of Dust Incharge and Sampling Incharge, see the chapter on 'Dust'.

●

Chapter 2

DEFINITIONS AND STATUTORY PROVISIONS

Q. 1. Define :

(a) Flameproof apparatus (1992)
(b) Intrinsically safe apparatus (2005)
(c) Auxiliary fan (2010)
(d) Booster fan (2011)
(e) Misfire (2011)

Flameproof apparatus

Means an electrical apparatus whose electrical parts are enclosed in enclosure,

- that can withstand without injury any explosion of the inflammable gas that may occur within it, and
- can prevent transmission of such flame as will ignite the inflammable gas which may be present in the surrounding atmosphere.

(It is an electrical apparatus inside a flameproof enclosure)

Intrinsically safe apparatus

Means an electrical apparatus which is so designed that

- any sparking that may occur in normal working is incapable of causing explosion of inflammable gas.

Auxiliary fan

Means a forcing fan or an exhausting fan used belowground

- for ventilating one or more faces of a ventilating district.

Booster fan

Means a mechanical ventilator used belowground

- for boosting the whole current of air passing along the intake or return airway
- of a mine or ventilating district.

(It is a more or less permanent installation. Auxiliary fan is shifted frequently).

Misfire

If the charge or a part of the charge in a blast hole does not explode due to any reason, it is termed a misfire.

Q. 2. Define the following :

(a) Reportable injury (1998, 2000, 2010)
(b) Minor injury (1992)
(c) Serious bodily injury (1998)
(d) Graham's Index (1998, 2002)
(e) Permitted explosive (1998)
(f) Competent person (1992, 1998, 2010)

Reportable injury

Means an injury

- other than a serious bodily injury,
- which involves, or in all probability, will involve,
- enforced absence of the injured person from work for a period of 72 hours or more.

Minor injury

Means an injury

- other than a reportable injury or serious bodily injury,
- due to which the injured person is forced to absent from work for more than 24 hours but less than 72 hours.

Serious bodily injury

Means an injury

which has resulted in, or in all probability will result in, the following :

- permanent **loss of** any part or section of the body, or
- permanent **LOSS OF use of** any part or section of the body, or
- permanent loss or injury to sight or hearing, or
- any permanent phycical incapacity, or

- fracture of any bone, or one or more joints, or bones of phalanges of hand or foot.

Graham's Index

In a colliery, the ratio of carbon monoxide produced to oxygen consumed, expressed as a percentage, is called Graham's Index, i.e.;

$$\text{Graham's Index} = \frac{\text{CO produced}}{O_2 \text{ consumed}} \times 100\%$$

Note : 1. Even in normal workings, air in contact with coal causes its slow oxidation. In this process some oxygen is consumed and small amount of CO (and CO_2) is produced, and the Graham's Index remains more or less constant. This is characteristic of the colliery and in Indian mines it may be between 0 and 0.1.

As temperature of coal rises, the ratio of CO produced to O_2 consumed increases. i.e. the Graham's Index increases.

Graham's index

0.5 - heating is certain

1.0 - serious heating approaching active fire

With rise in intensity, the index may rise up to 10% or more.

In other countries, upto 0.5 normal, 1.0 heating certain, 2.0 serious heating, 3 & above active fire.

2. Graham's Index is also known as Graham's Ratio or 'CO/O_2 deficiency' ratio.
3. To detect spontaneous heating. Graham's Index for every depillaring district is determined once a month by drawing samples of return air and analysing them.
4. This Index is used to know the status of heating inside a sealed off fire area also. For this air samples are drawn and analysed at regular intervals.

Permitted explosive

Means an explosive

- manufactured by such firm and of such type,
- as DGMS may specify, from time to time,
- by notification in the Official Gazette.

Competent person

Competent person, in relation to any work or any machinery (or plant or equipment) means,

- a person of age 20 years or more,
- who has been duly appointed in writing by the manager as a person
- COMPETENT to
  - supervise or perform that work, or
  - supervise the operation of that machinery (plant or equipment),
- and who is responsible for the duties assigned to him.

It includes a shotfirer.

Q. 3. Define the following :

(a) Free face (1998)

(b) Incubation period (1998, 2003)

(c) Gassy seam of 1st degree (1992)

(d) Gassy seam of 3rd degree (1998)

(e) Fiery seam (1992)

Free Face

Free face is an exposed coal or rock surface to which the explosive charge can break out.

An undercut, overcut or sidecut in coal provides a free face for optimum blasting.

In stone drifts or in solid blasting, the first few blasted holes provide a free face. These holes are known as 'cut' holes. Examples–wedge cut, burn cut, pyramid cut, drag cut.

Incubation Period

This is the period which elapses between the time when coal is first subjected to conditions favourable for spontaneous heating and the time of indications of heating.

In a mine worked by open caving, the time period from the date of first major fall to the date of indication of heating is taken as incubation period.

This counting is done from the date of first major fall of roof in the goaf because from that date left-over coal in the goaf gets buried under broken rock and the heat of oxidation does not dissipate fast enough leading to heat build up.

Incubation period in Jharia coalfield has been found to be 9 to 12 months. In Assam coalfield it is 2 to 6 weeks.

Gassy seam of 1st degree

Means a coal seam (or its part)

- lying within the boundary of an u.g mine,
- in which inflammable gas has not been found at any place in its workings belowground, or
- if detected, gas is not more than 0.1%, and its rate of emission does not exceed $1 m^3$ / tonne of coal raised.

Gassy seam of 3rd degree

Means a coal seam (or part thereof),

- lying within the precincts of a mine (not being an opencast mine),
- in which rate of emission of inflammable gas does not exceed $10\ m^3$ per tonne of coal raised.

Fiery seam

Fiery seam means a seam, in which

- fire or spontaneous heating exists in workings belowground, or in opencast workings,
- lying within precincts of the mine.

Note

Gas degree	% of inflammable gas in general body of air	Rate of emission of gas m^3/te of coal raised
I	less than 0.1	less than 1
II	more than 0.1	1-10
III		more than 10

Q. 4. Define :

(i) Face, (ii) Working place, (iii) Goaf, (iv) River, (v) Overman. (2005)

Face

Means

- the moving front of any working place, or
- the inbye end of any gallery, roadway or drift.

Working place

Means a place in a mine to which any person has lawful access.

Goaf

Means a part of workings belowground wherefrom

- a pillar or part thereof has been extracted, or
- in case of longwall workings, coal has been extracted,
- but which in not a working place.

River

Means any stream or current of water,

- whether seasonal or perennial, and
- includes its banks extending upto the highest known flood level (HFL).

Overman

Means a person possessing a *Manager's* or Overman's certificate,

- who is appointed by the manager in writing, *under any designation* whatsoever,
- to perform the duties of *supervision* or *control* in the mine or part thereof, and
- is superior to a sirdar.

Q. 5. Define :

(a) Official (1992,1998)
(b) Competent Person (1992, 1998, 2011)
(c) Week (2011)

Official

Means a person appointed in writing by the owner, agent or manager to perform duties of supervision in the mine/part of the mine. It also includes: Mining Sirdar, Overman, Assistant Manager, Under Manager, Ventilation Officer, Safety Officer, Engineer, Dust Incharge, Sampling Incharge, Surveyor.

Competent person

Competent person, for any work or any machinery, means a person-

- Of 20 years or more, duly appointed **in writing** by the

manager as person competent (1) to supervise, or (2) to perform that work, or (3) to supervise the operation of that machinery, and

- Who is responsible for duties assigned to him.
- It includes a shotfirer.

Week

Means a period of 7 days, beginning at mid-night of Saturday night, or such other night as may be approved in writing for a particular area by Chief Inspector or an Inspector.

Q. 6. State the statutory provisions in respect of the following :

(a) Riding or working in shafts. (1994)

(b) Travelling Roadways. (2003)

Riding or working in shafts

1.(a) No person shall get on or off a cage after it has been signalled to be set in motion, or leave it until it has reached the appointed stopping place.

(b) No person shall ride on top or edge of any cage except when engaged in examination, repair or any other work in the shaft.

2. At pit top, pit bottom or inset, every person shall obey the lawful orders and directions of the banksman or onsetter, as the case may be.

3.(a) Examination, repair etc. in shaft shall not be done when winding is in progress. When such work is being done, winding shall not be done except when necessary for such work.

(b) Before commencing work, the person incharge of such work shall intimate the banksman and winding engineman.

(c) A person engaged on such work shall be accompanied by atleast one other person, and all such persons shall be provided with effective safety belts unless otherwise efficiently protected against the risk of falling.

(d) All such persons shall be protected by suitable covering from objects falling from above. Every such person shall be provided with a protective hat, and shall wear the same when so engaged.

Travelling roadway

1. In every mine a travelling roadway shall be provided.
2. It shall
   - (a) have height not less than **1.8m,**
   - (b) be provided with suitable steps or ladders, where inclination is more than **30°**,
   - (c) be provided with hand rails or ropes in addition to steps or ladders, where inclination is more than **45°**,
   - (d) be provided, in addition to steps or ladders and rails or ropes, with suitable platforms at **10m** intervals, where inclination is more than **60°**.
3. Except for inspection, examination or repair, every person other than an official or a haulage attendant shall travel by the travelling roadway.
4. A cross-over bridge shall be provided where the travelling road crosses a haulage track or conveyor.

Note : Travelling roadway should preferably be in intake airway, it should not be circuitous and should not be changed from time to time.

Q. 7. Write statutory provisions for—

Taking shelter (2002)

Taking Shelter

1. Before a shot is charged, stemmed or fired, the shotfirer shall
   - see that all persons other than his assistants, in the vicinity, have taken proper shelter,
   - shall also take suitable steps to prevent any person approaching the shot, and
   - shall himself take adequate shelter, along with his assistants before firing the shots.
2. **In case of an opencast working,** the shotfirer shall not charge or fire a shot–
   - (a) Unless he has taken precautions laid down in (1) above.
   - (b) Unless **sufficient** warning, by **efficient** signals or other means approved by the manager, is given over the entire area falling within a radius of **500** (five hundred) metres

from the place of firing (referred to as the Danger Zone), and also he has **ensured** that all persons within such area have taken **proper** shelter, and

(c) Where any part of a **public road or railway lies** within the danger zone, unless two persons are posted, one each in either direction at the two extreme points of such road or railway which fall within the danger zone, who have, by an efficient system of telephonic communication or hooter or loud speakers (or other means approved by Chief Inspector or Regional Inspector) intimated clearance of traffic to be shotfirer and have also warned the passers-by and wherever possible the vehicles also, if any, which have passed by such road or railway.

If blasting is done by approved method of **muffle blasting** (where blasting projectiles cannot fall beyond 10 metres), the above precautions (b) & (c) need not be taken.

(d) If a permanent building or structure, not belonging to the owner of the mine, lies within the danger zone –

- total charge in all holes shall not exceed 2kg, or if delay action detonators are used, it shall not exceed 2 kg in each hole.
- if the building structure is within 50m of place of firing, blasting shall not be done without permission from the Chief Inspector or the Regional Inspector.

3. Where the workings, either opencast or belowground, offer insufficient protection against flying fragments or missiles, **adequate shelters** or other protection shall be provided.
4. When two working places belowground have approached within 4.5m of each other, the shot-firer shall not fire shots in any one of the said workings unless all persons have been **withdrawn** from the other working place and the same has been **fenced off** as to prevent persons inadvertently coming in direct line of shot.

Q. 8. What precautions are required to be taken against eruption of gas, as per Coal Mines Regulations?

Precautions against eruption of gas

Where any working is extended to within 30m of any goaf or disused working, containing or likely to contain an accumulation of inflammable or noxious gases,

- there shall be maintained at least one bore hole not less than 1.5m deep in advance of the working,
- the borehole shall be drilled under supervision of a competent person, and
- no lamp or light other than approved safety lamp or torch shall be used in any such working.

Q. 9. What are the provisions of regulations regarding withdrawal of supports?

Withdrawal of supports

Whenever supports are to be withdrawn, the withdrawal shall be done in accordance with the method specified in Manager's Standing Orders. The Standing Orders shall cover—

(a) supply and use of appropriate tools and safety contrivances;
(b) setting of extra supports to control collapse of roof from which supports are being withdrawn;
(c) sequence of withdrawal of supports; withdrawal of a cog to precede withdrawal of its corner props;
(d) safe positioning of persons engaged in the operation and all persons present nearby;
(e) training of competent persons who are entrusted with the operation, and
(f) supervision during withdrawal of supports.

Q. 10. Write statutory provisions on—

Installation and use of auxiliary fan in u.g.mine.

(1985, 1997)

Installation and use of auxiliary fan

1. Every auxiliary fan :
   (a) shall be installed, located and worked in such a manner that :
      (i) sufficient air reaches it all the time so that it does not re-circulate air,

(ii) circulating air shall not have substantial quantity of inflammable or noxious gases or dust,

(b) shall be earthed to avoid accumulation of electrostatic charge, and

(c) shall have an air-duct, which shall be so maintained that adequate air reaches the face or blind end.

2. Operation, removal etc. shall be done by or on authority of an official.
3. No person shall enter or remain in any place which is ventilated by an auxiliary fan, unless the fan is operating efficiently, except for restoring ventilation, and after the place has been examined by a competent person and declared safe.
4. In any fiery seam or gassy seam of 2nd or 3rd degree, more than one auxiliary fan shall not be installed in the same ventilation district without permission from Regional Inspector.

Q. 11. State provisions of the regulations for the following :

(a) Use of coal cutting machines in a degree III gassy mine. (1993)

(b) Use of permitted explosive. (1993)

Use of CCM in degree III mine

1. No shot shall be fired in coal unless
   - (i) the coal has been undercut, overcut or side cut, and
   - (ii) length of the shothole is atleast 15cm less than depth of the cut.
2. The coal cutting machine and switches shall be flame proof.
3. The person appointed to supervise maintenance of the CCM/electrical system, and the CCM driver shall be holders of gas-testing certificate. Every such person shall whilst on duty be provided with and carry an approved flame safety lamp.
4. Before taking machine to the face and before commencing cutting operations, face shall be checked for presence of gas.
5. If at any time gas is detected at the face, the machine shall be stopped and power cut off.

6. Effective steps shall be taken to prevent generation of frictional sparks and accumulation of gas in the cut.
7. Wet cutting arrangements shall be provided on the CCM and used.

Precautions in use of permitted explosives

1. No shothole shall be fired in coal unless the coal has been undercut, overcut or sidecut, and the shothole is atleast 15 cm shorter than the depth of the cut.

   Aggregate charge in any shothole in coal shall not exceed permissible maximum charge notified by the DGMS for that type of explosive.
2. No detonator shall be used unless it is an electric detonator with a copper tube.
3. Where more shots than one are charged, they shall be fired *simultaneously*. If *delay action detonators* are to be used, prior permission in writing, from Chief Inspector shall be taken and stipulated conditions followed.

4.(a) If inflammable gas is detected in any place, no shothole shall be charged, stemmed or fired in that place or in any other place on its return side in that ventilating district till such place has been cleared of gas and declared safe.

(b) Immediately before charging a shothole or a round of shotholes and again before firing the shots, the shotfirer shall carefully test for inflammable gas at all places within a radius of 18m of the place of firing.

(c) No shothole shall be charged if any break is found therein, or if inflammable gas is found issuing therefrom.

(d) If after charging a shot-hole, inflammable gas is found in any place within prescribed radius (18m), no shot shall be fired until the place has been cleared of gas and declared safe.

5. Shots shall be fired by an approved exploder only.

Note : 1. In the regulations, the words 'Chief Inspector' and 'Regional Inspector' have been used. Chief Inspector has also been designated as Director General of Mines Safety (DGMS), and Regional Inspector as Director of Mines Safety (DMS).

2. In recent years, DGMS has permitted use of copper coated steel detonators with special conditions.

Q. 12 Write statutory provisions for:

(a) Notice of disease. (2009)

(b) Notice of accident. (2008, 2012)

Notice of disease

If any person employed in a mine contacts any disease notified by the Central Govt. in the Gazette, the owner, agent or manager (**O, A or M**) shall, within 3 days of getting information of the disease, give a notice thereof (in Form V) to :

Chief Inspector

Regional Inspector

Inspector of Mines- Medical

Coal Mines Labour Welfare Commissioner.

Note : For *Notified Disease*, see the chapter on Mines Act & Mines Rules.

Notice of accident

1. When there occurs in or about a mine an accident causing loss of life or serious bodily injury in connection with mining operations, or other specified accident/dangerous occurrence, the Owner, Agent or Manager (O, A or M) shall-
   (a) forthwith inform Regional Inspector. In case of electrical accident, inform also Electrical Inspector of Mines.
   (b) send a notice within 24 hours to Chief Inspector, Regional Inspector and District Magistrate,
   (c) post a copy of the above notice on a special notice board at office of the mine (to be kept legible for 14 days),
   (d) in case of death or serious injury, within 7 days, send details in Form IV-B to Chief Inspector,
   (e) if death results from any injury already reported as serious, or an injury other then serious becomes serious, give notice to the above authorities.
2. Specified accidents/dangerous occurrences :
   (i) Explosion or ignition
   (ii) Spontaneous heating or fire, or indication of the same
   (iii) Influx of noxious gases
   (iv) Eruption of water
   (v) Instantaneous failure of a pillar/s (i.e. a bump) in workings belowground
   (vi) Premature collapse of workings
   (vii) Overwinding
   (viii) Breakage or fracture of rope, chain, headgear pulley or axle or bearing thereof, or other gear by which persons are lowered or raised
   (ix) Breakage or fracture of an essential part of winding engine, drum, emergency brake or other part
   (x) Bursting of steam or compressed air equipment
   (xi) Breakage, fracture or failure of an essential part of a machine or apparatus endangering safety of persons
   (xii) Sliding of OB dump.

Q.13 What precautions will be taken before abandoning a mine? (2009)

Precautions before abandoning a mine

1. **Notice :** 40 days before intention to abandon the mine, a notice shall be sent to Chief Inspector and Regional Inspector. If there is a railway line, public road or permanent structure (on surface), notice shall be sent to the concerned authority also.
2. **Protective works :** as directed by Chief Inspector, Regional Inspector or public authority, all protective works shall be completed, for example,
   - Completion of stowing
   - Closing any connection with an adjacent mine
   - Strengthening inter-mine barrier
   - Protective works for surface structures
   - Permanent closing of mine entries
   - Sealing surface boreholes
   - Sealing surface cracks, blanketing, fencing
   - Removal of haulage engine and other surface structures

which may pose danger to public. Fencing around water tank.

3. Sending an updated abandoned mine plan to Chief Inspector. It shall show all water dams (with particulars), spot levels at ends of galleries etc.
4. 7 days before abandoning, sending information to Chief Inspector, Regional Inspector and District Magistrate.
5. Completing all jobs as per the mine closure plan and handing over leased land to State Government.

●

Many other questions on statutory provisions have been given in relevant chapters for easy understanding and retention.

Chapter 3

GEOLOGY

Q. 1. List the geological disturbances commonly found in Indian coal mines.

Common geological disturbances

1. Dyke
2. Sill
3. Fault
4. Wash-out
5. Roll
6. Fold
7. Splitting of seam
8. Slips

Q. 2. What is a dyke? How does it affect the mine working?

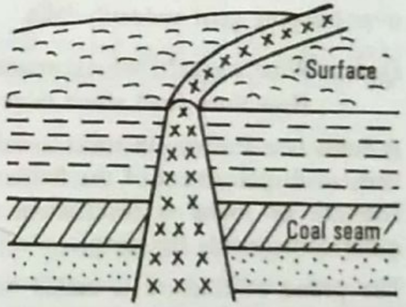


Fig : **Dyke**

Dyke is a more or less parallel sided vertical *wall of igneous rock* formed due to upward intrusion of molten magma generally through fissure or cracks extending in the previous rocks. Some dykes may be small and local; others may be as thick as 20m, extending upto several kilometers. In some seams, a series of dykes may be found.

In Indian coalfields, dykes are of dolerite or mica-peridotite (the ultra basic rock which is more fluid).

Coal in proximity of a dyke is burnt to *jhama* which is difficult to win and of little utility.

Dykes cause interruption in mining operations and make mechanised mining difficult. They also create strata control problems. Drilling and blasting to cross the hard material of *jhama* is a costly affair.

Q. 3. What is a sill? What harm does it cause?

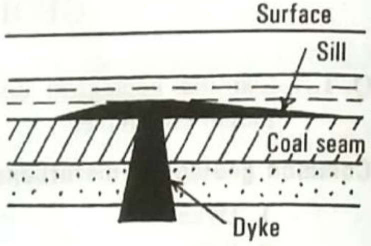


Fig : **Sill**

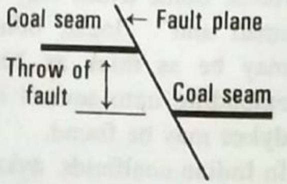
Sill is a sheet of igneous rock spreading in bedding planes in stratified rocks. It may cut across and go from one to another bedding plane. A sill may be a few centimetres to several metres thick and may cover large areas. A sill is connected with dyke at some or the other place through which the hot magma has come and spread. Sills are of hard stone (dolerite or mica-peridotite).

A sill burns a part thickness of the coal seam or it may render the entire coal seam *jhama*. In some cases coal may be thermally metamorphosed to a higher rank. A number of coal seams in Jharia have been burnt to powder.

A sill at top of a coal seam forms a very strong roof which is difficult to cave and may result into an air blast when a large over-hanging goaf suddenly falls.

Q. 4. What is a fault? What is meant by fault plane and fault throw? How does fault affect mine working?

A **fault** is a fracture in rocks usually associated with lateral or vertical displacement of the fractured beds. Faults occur when strength of rocks is insufficient to withstand stress due to movements inside the earth.



The plane of fracture is called the **fault plane**. Vertical displacement of the fractured bed is called **throw of fault**; it is measured from floor to floor of the seam.

Faults are the most dominant geological disturbances.

Faults affect the working of mine as follows:

1. Strata in vicinity of fault are generally found crushed to a mass (of large angular fragments and finely crushed material i.e. **fault breccia** which is the result of crushing due to movement of one wall against another, and there is presence of polished surfaces called ***slicken sides***) causing problems in support. The crushed material/slicken sides may fall without indication.
2. Due to sudden change in level and gradient, mechanised mining becomes difficult.
3. Costly long drifts have to be driven to catch the seam on other side of the fault.
4. Faults are locales of heavy gas and water inflows.
5. Coal barriers left on either side of fault plane become sites of spontaneous heating.
6. Dangerous inrushes of water many take place from one seam to the other.
7. The weak plane of fracture may cause serious slides at faces and sides in O/C mines.
8. In some cases, faults have up-thrown the seam or caused repetition of outcrops making it easy for mining by O/C method.
9. Sudden changes of dip near the fault may create problems in haulage.

Note : 1. Jharia coalfield is criss-crossed by about 300 major faults of length varying from 100m to 12km and throw from 10m to 300m.

These major faults are associated with sympathetic faults of lesser throws. In addition to these, there are many small throw faults which may not extend from one seam to other.

2. It is worth noting that during prospecting, faults of throw 5m or more only are detected. Smaller throw faults are detected during mining operations. Hence mining officials have to be careful.

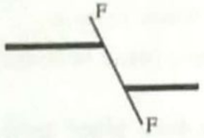
Q. 5. What are the different types of faults?

Faults are of three types :

1. **Normal fault** : Fault in which ends of broken strata move away (*do not overlap*) is called normal fault. Normal faults occur in areas of tension in the strata. Such faults are commonly found in Indian mines.
2. **Reverse fault** : Fault in which the older rocks are thrust over

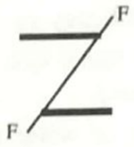
the new ones by lateral compression so that ends of the broken strata *overlap* each other is called reverse fault. Reverse faults occur when the strata are compressed into a space less than their original extension. Such faults are common where strata are intensively folded as in case of Assam.

3. **Trans-current fault** : Fault in which the broken ends of strata remain in the *same level but move away* from each other is called trans-current fault. Such faults are also found in folded strata.



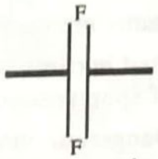
Normal fault

(broken ends do not overlap)



Reverse fault

(broken ends overlap)



Trans-current fault

(broken ends move away inthe same level)

Q. 6. What are the indications of a fault? What are slips?

Indications of a fault

1. Occurrence of stone in place of coal in the face.
2. Sudden change in direction and amount of dip.
3. Gradual rise or fall of roof and floor.
4. Progressive reduction in thickness of the coal seam.
5. Presence of slips, cracks, slicken sides.
6. Presence of crushed zone in the seam.
7. Change in seepage of water from roof or floor.
8. Increase in emission of gas or, emission of gas at a place where gas had never been found earlier.

Slips

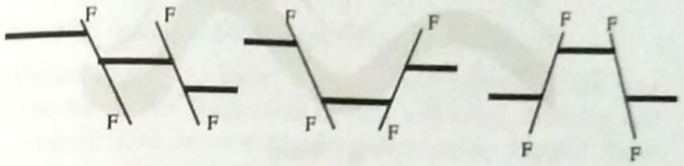
Slips are small but clear cut fractures, sometimes slickensided (polished), occurring often in groups. They are often covered with layers of carbonate mineral making the roof liable to fall suddenly without indication.

Q . 7. What is the difference between step fault, trough fault and ridge fault?

At some places several faults are met one after the other in the form of steps. Such faults are called **step faults**.

If a down-throw fault is followed by an up-throw fault, a trough is formed. Such group of faults is known as **trough fault**.

If an up-throw fault is followed by a down-throw fault, a **ridge fault** is formed (see sketch below).



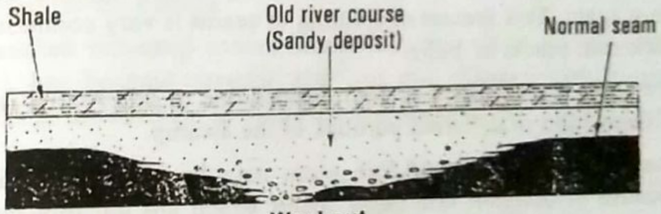
(a) step fault (b) trough fault (c) ridge fault

Q. 8. What is a wash out?

A **wash out** is an irregularity causing local thinning of coal seam or its entire disappearance, generally due to erosion by a river or stream. The eroded portion is filled up with coarse sediments.

Sudden thinning causes problems in mining. Loose roof rocks (sediments) present problems in support.

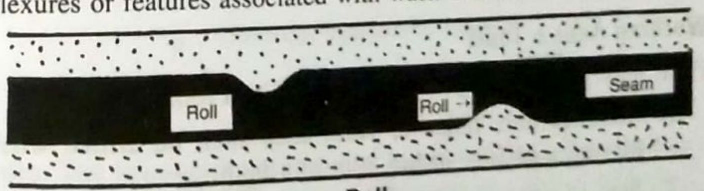
In case of disappearance, a new mine may have to be opened to work the other side of the seam.



Washout

Q. 9. What is a roll?

Undulations in a coal seam which may be due to local and minor flexures or features associated with wash outs are known as **rolls**.



Roll

Q. 10. What is a fold?

Folds are bends, up or down in rocks subjected to severe forces. Folds are not common in Indian mines except for those in Assam and Jammu & Kashmir where the strata are intensely folded.

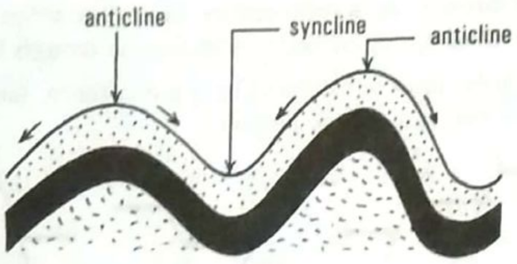


Fig : **Fold**

The folded rocks are found under strain. They are frequent locales of fire damp and water. Folding causes change in gradient of the seam which creates haulazge and pumping problems.

Q. 11. What is meant by seam splitting?

In some seams, shale and sandstone bands or partings may increase in thickness so that the seam is divided into a number of thinner seams or splits. At a long distance, the split portions may gradually come closer and join together to form a thick seam again. This feature of splitting of seams is very common in thick coal seams of India.

The splits are supposed to have formed due to differential rates of deposition in different portions of the swamp.

Due to splitting, a workable seam may become unworkable because of division into many seams which are too thin to be worked economically.

Q. 12. A gallery is approaching a fault. To what points will you pay attention?

Working near a fault

Fault may present dangers of gas, water and roof fall.

1. Advance bore holes of 1.5m deep shall be drilled when driving a gallery within 30m of a fault.
2. Size of gallery shall be reduced and no junctions shall be formed in the fault zone.
3. On either side of the fault, a solid barrier of coal shall be left.
4. No blasting shall be done.
5. Good ventilation shall be ensured.
6. Frequents checks for gas shall be made with safety lamp and approved detectors.
7. Careful watch shall be kept on seepage of water.
8. Before the main fault, several small faults or slips may also be found. Inspection of roof and sides, dressing and support shall be carefully done. Systematic Support Rules shall be enforced. Freshly exposed roof shall be quickly supported. If conditions demand, forepoling may be done. Supports shall be maintained tight. Gallery shall be driven according to the centre line marked by surveyor. Gallery shall not be unduly widened or heightened.
9. Work shall be done under constant supervision of experienced mining sirdar/ overman.

Q. 13. What are out-crops and concealed out-crops?

An **out-crop** of a coal seam or strata is that part of it which is exposed on the surface.

Concealed out-crop means hidden out-crop. It is an out-crop which has become covered with soil and alluvium and is not visible at the surface. It is also known as 'in crop'

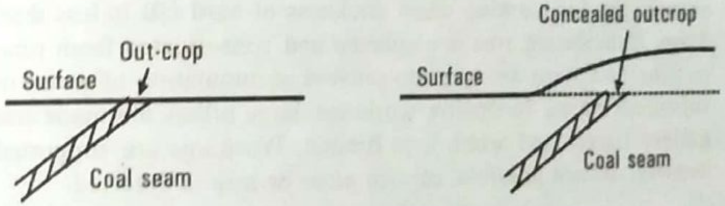


Fig : **Outcrop, concealed outcrop**

Q. 14. What are dip, apparent dip and strike?

Inclination of a coal seam or strata from the horizontal is known as **dip**. The maximum dip is called true dip. Dip is described in degrees, such as 40^0, 50^0, or more commonly in 1 in 4, 1 in 5 etc.

Dip in a direction other than the true dip direction is known as **apparent dip**.

The dip at 90° to the true dip direction of coal seam or strata is

0°. This direction is known as **strike** direction. In the strike direction, the coal seam or strata is found level.

Note : How to convert gradient 1 in 6 and 1 in 4 in degrees?

Remember the number 56

Gradient 1/6 = 56 x 1/6 = 9° (approx)

Gradient 1/4 = 56 x ¼ = 14°

Q.15 What is a pothole? What are its dangers?

Pothole

Pothole is a well like surface subsidence, formed by flowing away of sandy or soft strata material into u.g. workings or goaf. Its depth may be 40-45m.

Potholes are generally formed when u.g. workings below weak/sandy strata are advanced towards a fault and there is accumulation of water on surface. Water reduces the strength of soft strata and results in subsidence.

If pothole occurs within HFL area of a river/*nalla* or an accumulation of rain water on surface, it may inundate the mine.

Potholes have occurred in several mines like Majree, Bada Dhemo, Korba, Surakachar, Lachhipur, Khas Kajora, Sarpi Kajora, Mahabir, Ballarpur etc.

To prevent occurrence of potholes, DGMS does not grant permission for working when thickness of hard OB is less than 7.5m. Subsidence area is blanketed and consolidated from time to time and steps are taken to prevent accumulation of water in subsidence area. In shallow workings, large pillars are made and gallery height and width kept limited. Workings are supported heavily. Where possible, surface *nalla* or *jore* is diverted.

●

Chapter 4

BORING, DRIFTING, SHAFT SINKING AND MINE OUTLETS

A. Boring

Q. 1. What are the purposes for which boring in done in mines?

Purposes of boring

Boring is done in mines for many purposes, some of which are as follows :

1. To prove existence of coal seams. To get details like extent, depth, thickness, gradient of coal seams, thickness and nature of strata above and below the seams. To know the quality of coal, coal reserves, existence of faults, folds etc.
2. On meeting a fault, to prove the position of seam on other side of the fault.
3. To drain off water or gas from old workings.
4. To prove thickness of barriers against waterlogged workings or against an adjacent mine.
5. To know the thickness of a dyke.
6. To carry electric cables stowing or water pipe ranges from surface to underground.
7. To drain off gas (gas drainage).
8. While working contiguous seams, drilling at gallery junctions, to check correct superimposition.
9. To know the nature and thickness of rocks before sinking a shaft.
10. For cement injection around water dams.
11. To establish contact with workers stuck up u.g. due to fall of strata or inundation, to reach them air, snacks/drinks, medicines and to communicate with them Boring of large dia holes to bring the workers to the surface.
12. For sending stone dust into old u.g. workings while extracting pillars by opencast method.

B. Drifting

Q. 1. A 200 m long drift 4.5m × 2.7m is to be driven with a gradient of 1 in 6. Describe briefly the method of drifting to get a progress of 40m per month.

Drifting

For a 4.5m × 2.7m drift, an excavation of 5m × 3m would be required. Various operations will be as follows :

1. **Drilling :** Holes for blasting will be drilled by airleg mounted compressed air drills. At a time 2 drills may be worked. In the drift of given size 45 to 50 holes 1.5m deep may be drilled on wedge cut pattern at an approximate rate of 3 holes per m^2 of area of cross section. Compressed air may be reached to the face at $6 kg/cm^2$ by a 150mm dia pipe line. Bits used would be tungsten carbide tipped. One drill will be kept spare u.g. and two on the surface-well maintained and ready for use.
2. **Blasting :** 4 cartridges of 150g Ajax-G may be charged per hole with delay detonators of 0 to 5 delay numbers. Holes will be stemmed by wet clay cartridges. About 30 kg explosive would be consumed per round to get a progress of 1.4m. A 250m long shotfiring cable may be used, with approved exploder and circuit tester.
3. **Loading and transport :** Blasted rock will be loaded into tubs by $1m^3$ capacity Eimco loader. There will be two tracks near the face—one for the loads and the other for empties. Tubs would be drawn by a 30 kW direct haulage.
4. **Support :** Arch supports of 30 kg rails will be set at 1m intervals. Arch sections shall be joined by fish plates and bolts.
5. **Ventilation :** For ventilation a 7 kW exhaust auxiliary fan with 600mm steel tubings shall be used. After advancing about 100m, a second auxiliary fan of same capacity shall be installed in series. To clear the blasting fumes quickly, compressed air will be released from compressed air pipe at the face.
6. **Pumping :** Water will be pumped by Roto or Mono pump of capacity suiting the discharge.

7. **Surveying :** Surveyor will inspect the drift frequently and take required measurments to ensure it is driven as per the centre line and with correct gradient. He will extend the centre line and grade line also.
8. **Manpower :** Work shall be organised on 'all men all jobs' system, with a team of 10 persons. Mining Sirdar and Overman will supervise the operations.
9. **Cycle of operations and progress :** A cycle of operations will take 16 hours.

Drilling	:	4 hours
Shotfiring, smoke clearance, dressing	:	2 hours
Loading	:	3 hours
Support setting	:	4 hours
Shift change and idle time	:	3 hours
Total	:	16 hours

Progress may be 1.5 m per day or 40m per month (considering breakdowns).

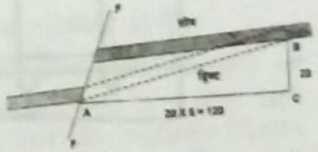
Q. 2. A decision has been taken to drive a drift to cross an upthrow fault of 20m. Give a layout, with blasting, support, ventilation, machinery and manpower for getting a progress of 0.5m per day. (2006)

Hint : Assuming drift gradient 1 in 6, to cover throw of 20m,

$$\text{length of drift } AB = \sqrt{AC^2 + BC^2}$$

$$= \sqrt{(120)^2 + (20)^2}$$

$$= 122 \text{ m (approx.)}$$



Assuming drifting to be done one shift per day,the question can be answered as in Q. 1. above.
Since fault is to be crossed, and it is a rising drift, additional precautions will be taken as follows :

- vigilant gas checks
- good ventilation
- prompt dressing & support
- only light blasting
- arrangement of pumping near drift mouth where drift water will flow down.

C. Shaft Sinking

Q. 1. Describe method of temporary support in a sinking shaft.

Temporary Support in a sinking shaft

Temporary support in a shaft is done by steel rail skeleton rings and wooden planks. Each ring is made up of 3 to 4 segments which are joined together by fish plates and bolts. The first ring is hung by chains from rails driven vertically into the ground at surface at a safe distance from periphery of the shaft. Each subsequent ring is hung from the one above by steel hooks or hangers. Wooden planks 2m long and 250 × 25cm in section are placed behind two rings (set 1.2 to 1.5m apart) and tightened by wooden wedges. Every 4th or 5th ring is additionally supported by plugs placed into holes drilled horizontally in the shaft side. Each ring is first fitted on surface, checked, opened, matching ends marked and then taken down to ensure correct fitting.

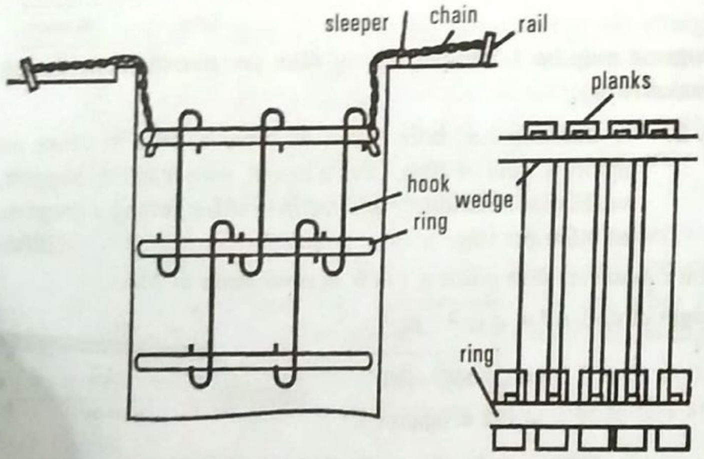


Fig : **Temporary support in sinking shaft**

Note : After some distance, a foundation is cut into the shaft sides to lay a concrete bed. Permanent support of brickwork is then built up on this foundation and temporary supports removed as permanent support progresses.

Q. 2. Describe drilling and blasting operations in a sinking shaft.

Drilling-blasting operations in a sinking shaft

After pumping out water from the shaft bottom, centre of shaft is marked by drilling a hole. Holes for blasting are drilled as per the designed pattern by 5-6 compressed air hammer drills mounted on a special frame. Supply of compressed air is drawn from compressed air pipe, secured to the shaft sides, by hose pipes through a multiple-jet fitting. The drill steels are fitted with tungsten-carbide tipped bits. Holes may be 38mm dia 1.2 to 1.5m deep.

After drilling a hole it is cleaned by compressed air, a short length of steel rope is inserted for later cleaning and the hole is fitted with a wooden plug about 0.5m long.

Holes are drilled in a number of concentric rings using a cone or pyramid cut. The inner ring is known as cut holes, followed by sumpers, easers and an outer ring of trimmers. Number of holes may be calculated roughly as one hole per 0.3-0.4 m^2 cross-sectional area of excavation. For a 6m dia shaft 60-70 holes may be drilled in 4-5 rings.

After removing drills etc., the holes are cleaned and charged with explosives. Detonator leads are connected to shotfiring cable. Blasting is done by an exploder from surface or firing is done from the mains with special permission from DGMS. 1.2 to 1.5 kg explosive may be consumed per m^3 of rock depending on hardness of strata and the type of explosive used.

Q. 3. Describe ventilation, lighting and pumping arrangements in a sinking shaft.

Ventilation, lighting and pumping in sinking shaft

Ventilation : For ventilation generally a reversible forcing fan is installed on surface and air is taken down by a steel pipe range 600-700mm dia, made in sections, the adjacent flanges being joined by bolts after inserting a rubber joint ring. Air tubes are supported at 8-10m intervals in the shaft side by clamps. At the lower end, a canvas tubing is fitted which can be raised by a wire to prevent damage by shotfiring. After blasting, the fan is reversed to work as exhaust fan for quick clearance of blasting fumes and smoke.

Lighting : In addition to caplamps used by individual workers, a cluster of 8-10 bulbs of 100 watt, 110V, enclosed in a water tight fitting is used for illumination of shaft bottom. The fitting has a reinforced glass, an aluminium reflector and a steel or aluminium cage to protect the glass from damage. The fitting is attached at end of an armoured lighting cable coiled on a power operated winch installed on surface. The design permits raising or lowering of the lamp fitting without switching off the current. Cable is self supporting and the cable drum is fitted with a brake and pawl and ratchet gear. Lighting cable is suspended clear of shotfiring cable.

Pumping : Generally a stage pumping system is used. Water from the shaft bottom is pumped by compressed air operated small pumps to intermediate sump. Turbine pumps installed there pump water to surface through a delivery pipe range which is supported from permanent buntons.

Q. 4. Describe briefly the statutory provisions for winding is sinking shaft.

Winding in sinking shaft

1. If shaft is deeper than 45m, the sinking bucket shall be provided with a detaching hook (safety hook).
2. If depth exceeds **150m**,
   - the bucket used for lowering or raising persons shall be provided with sufficient cover overhead for protection from things falling down the shaft.
   - the bucket shall be provided with sufficient number of guide ropes, which shall be kept extended to within **22.5m** of the shaft bottom, when sinking is in progress.

3.(a) Two independent signalling systems shall be installed for exchanging signals between bottom and top of the shaft.

(b) A printed copy of code of signals shall be posted prominently at top of the shaft and also in the winding engine-room.

4. Bucket for travel of persons or for conveyance of materials shall be of strong construction.
5. At top of the shaft, suitable doors or covering shall be provided. The doors or covering shall always be kept closed except during passage of bucket.
6. If the shaft exceed **45m** in depth, persons working at the shaft bottom shall be protected by an adequate protective covering extending over whole area of the shaft except for an opening for passage of the bucket. The protective covering shall be kept lowered to within **22.5m** of the shaft bottom, when sinking is in progress.
7. Number of persons riding in the bucket at one time shall not exceed the number permitted by the manager, a notice of which shall be kept posted at top of the shaft.
8. Mining Sirdar or chargeman shall pay attention to ensure the following :

   (a) bucket is loaded properly

   (b) material is not loaded above the rim,

   (c) long timber, pipes, rails, tools or other material with ends projecting over the rim are securely fastened to the rope, chains or bow,

   (d) before being sent away, the bucket is steadied, and its bottom and sides are freed of adhering material.
9. For scaffold or platform in the shaft, the following precautions shall be taken :
   - Scaffold shall be secured to the shaft sides to prevent it from swinging.
   - Opening for passage of the bucket shall be protected as to prevent anything falling through it.
   - It shall not be lowered or raised except under orders of the chargeman or other competent person.

Q. 5. Give a list of safety equipment and appliances of a shaft being sunk.

Safety equipment and appliances of a sinking shaft

1. Fencing at the pit-top
2. Shaft top covers or doors
3. Signalling equipment (scaffold to banksman, banksman to winder operator & slaft bottom to banksman)
4. Signal code notice boards
5. Safety hook
6. Rider

7. Bucket catch hook
8. Ladder for getting into the bucket
9. Guide ropes
10. Notice indicating permissible maximum no. of persons riding the bucket at a time
11. Roof over scaffold
12. Bolts for securing scaffold to shaft walls
13. Fencing around opening in scaffold
14. Rope ladders from scaffold to pit-bottom
15. Permanent support/shaft lining
16. Temporary supports in the shaft
17. Ventilating fan & ducts
18. Blasting box/blasting cable
19. Pumps/pipes
20. Lights
21. Brakes of various winches
22. Winding engine brake, depth indicator.

Q. 6. After a holiday what checks are to be made by the overman before allowing men to commence work in a sinking shaft?

Inspection after a holiday

After a holiday, before allowing men to commence work in a sinking shaft, the following inspections have to be made :

Shaft top fencing, loose material lying near shaft top, signalling system, condition of bucket, ladder for entry into the bucket, permanent supports, temporary support of sides, dressing of shaft sides, accumulation of water, inflammable gas and CO_2 at the shaft bottom, condition of pumps, arrangement of ventilation and lighting.

Before allowing men to enter the shaft, empty bucket shall be checked by moving it up and down the shaft 4 to 5 times.

D. Mine Outlets

Q. 1. State the statutory provisions regarding mine outlets.

Statutory provisions regarding mine outlets

1. Every seam or section being worked should have two means of egress to surface (shafts, inclines or adits).

2. If there is only one means of egress, as happens during sinking of a shaft, or during making u.g. connection between two shafts, or while driving for search of mineral, the total number of persons working at a time in different seams shall not exceed **20**.
3. Both the outlets shall have suitable arrangements for persons to descend or ascend.
   - If the shaft is more than 30m in depth, such arrangements shall be by mechanical means.
   - where in any shaft, ladders are used as means of ingress or egress of persons employed in the mine, the ladder shall be :

     of strong construction,

     securely fixed in the shaft at inclination of not more than 80° from the horizontal,

     made continuous except at platfroms.

     platforms shall be provided at intervals of not more than 9m.

     rungs shall be equally spaced and at sufficient distance from the wall to ensure proper foothold.
4. Distance between two outlets shall not be less than **13.5m**.
5. Each outlet shall be connected with the other by a walkable passage not less than 1.8m × 1.5m, through the workings u.g.

   Whenever the connection becomes obstructed or dangerous, no persons shall be employed belowground except those necessary to clear the obstruction or to repair dangerous part of the connection or to make a new second outlet.
6. Every part of a mine shall, where practicable, be provided with atleast two routes of escape to surface.

Q. 2. State the provisions regarding working shafts.

Working shafts

1. Every shaft in use (or every incline or other outlet) shall be made and kept secure.
2. Sides of a sinking shaft upto a maximum of 20m from the

bottom shall be supported by iron or steel rings with substantial lagging, and shaft sides above it shall be supported by permanent lining of metal, concrete or masonary.

3. If in a shaft regularly used for lowering or raising of persons or materials, water seeps out of the strata, water garlands shall be provided for collecting and conducting away seepage water.
4. The top, all insets and the bottom of every working shaft and the sump shall be kept clear and free of loose material, tools and debris.

Q. 3. What is 'water garland'?

Water garland

Water garland is provided in shafts used regularly for men or material winding if water is seeping out from the sides. It is made of **concrete or steel**, and covers the entire periphery of the shaft. It is so made that all water seeping from shaft sides above is caught by the water garland. At the bottom it has a drainage pipe for leading the collected water to a sump. In deep shafts more than one water garland may be necessary, if seepage is at two depths. Water garland prevents intake air picking up moisture and becoming more humid. It also provents deterioration of winding ropes.

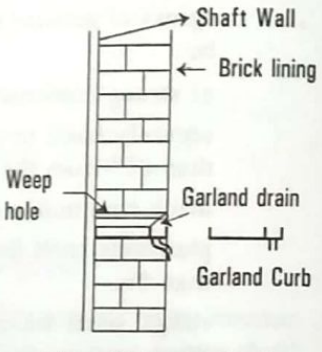


Fig : **Water garland**

Q. 4. What are the provisions regarding escape routes?

Provisions for escape routes

1. For escape from every u.g. working at least two escape routes clear and without obstruction shall be available.
2. These shall be indicated by markings/signs.
3. All workmen shall be made acquainted with the escape routes.
4. Escape routes shall be regularly inspected and kept maintained.

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Chapter 5

METHOD OF WORK

According to method of mining, coal mines are of two types.

- Opencast mines
- Underground mines

Opencast mine

In opencast method, soil and rock (called **overburden**) lying over small area of the coal seam is blasted, excavated and dumped on non-coal bearing surface nearby. The exposed coal is blasted and mined. Operations of removal of overburden and extraction of coal continue. After coal has been removed over a large area, the overburden is dumped in the trench formed by removal of coal. This is called 'back filling'.

Overburden is excavated in steps called 'benches' for reasons of safety and ease of extraction. Coal seam is also extracted in more than one bench if it is thick. Benches are approached by wide roadways called 'haul roads' because they are used for transporting or hauling of overburden or coal.

As depth increases, more overburden has to be removed per tonne of coal and cost goes up. After mining the seam to an economic depth, rest of the seam is worked by underground method.

Advantages of opencast method

Wherever conditions permit, coal is mined by opencast method because it has several advantages. The method is cheap and safe. There are no problems of ventilation, gas, fire, explosion, inundation and roof falls. High rate of production can be achieved quickly by employing large machinery. But if the coal bearing area is under surface features like villages, important roads, railway lines, rivers-nallas, fertile land or forest area, and these are to be saved, or if the seam is situated at a great depth or is steeply dipping, coal has to be mined by underground method.

Opencast mines are managed by manager, under/asstt, managers, engineers (excavation and electrical-mechanical) and foremen, but the primary mining supervision is done by mining sirdars and overmen.

In India about 85% of coal production comes from opencast mines.

Underground mine

Where the coal seam is situated at a shallow depth, it is reached from surface by inclines. A deep seated seam is approached by shafts. Whether the seam is approached by inclines or shafts, method of extraction of coal is more or less the same.

A roadway in coal seam is called gallery. A gallery driven along the strike of the seam is called level gallery. A gallery driven along the dip is called dip gallery. A gallery driven in a direction opposite to the dip direction, is termed rise gallery.

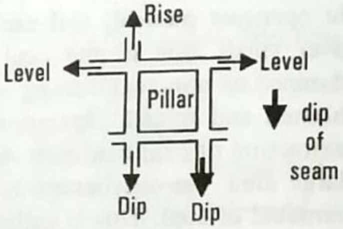


Fig : **Pillar and Gallery**

In olden days, gallery was called 'bord'. Solid block of coal left between galleries is called pillar. Hence the method was called 'Bord & Pillar' method. Pillars serve as natural supports.

In u.g. mines, coal is usually extracted by one of the following three methods—

- Bord and Pillar method
- Longwall method
- Room and Pillar method

Bord and Pillar method

In this method coal is extracted in two steps, called development and depillaring.

Development

Development is the work of drivage of level and dip-rise galleries to form pillars. Seam is developed in panels upto mine boundaries. Two panels are separated by solid barriers of coal, one pillar thick. These are called **panel barriers.**

Depillaring

Once a panel has been developed upto the mine boundary, the work of extraction of pillars starts from the boundary. This is called **depillaring.**

If after extraction of coal, roof is allowed to fall, it is called **depillaring by caving**. If the excavated area is filled up with sand, the method is known as **depillaring with stowing**.

Once coal extraction in a panel is completed, its approaches are sealed by brick stoppings. If this is not done, the coal left out in the goaf would develop **spontaneous heating** and fire.

Longwall method

In this method, two galleries are driven 60 to 200m apart for a distance of 800-1000m. A cross gallery is driven to join them. One side of this gallery like a long wall then forms a face, along which coal is extracted. Hence this method is termed longwall method. In simple words, longwall method is a method of extraction of coal by 60 to 200m long faces.

Longwall method is common in many other countries. It has been tried in a few mines in India. Initial attempts were half hearted. Recently the method has been adopted in a few mines with Chinese assistance. It will take a long time and sincere efforts to absorb the technology, but the method has much potential, where conditions permit, especially because India has to increase production from u.g. mines in view of more coal reserves mineable by u.g. methods, and limited reserves mineable by opencast method. Seams at great depths can be worked by longwall method only.

Room and Pillar method

This is similar to Bord and Pillar method, but the galleries are wide. Seam is developed by continuous miners and shuttle cars. The same machinery is used for extraction of pillars also. The method of development has been explained with a sketch under the heading 'development' in pages ahead. This method has been recently introduced in India in a few mines.

Note : Questions and answers concerning development by Bord & Pillar method are given below. Depillaring, Longwall and Stowing operations will be discussed in separate chapters.

Bord & Pillar Method

Development

Q. 1. Write briefly the statutory provisions for mine development.

Statutory provisions for mine development

1. Mine will be developed in panels. Barrier between two panels shall be one pillar thick.
2. Height of any gallery at any place shall not exceed 3m and the width shall not exceed 4.8m. For mechanised mining, DGMS may permit larger width.
3. Size of pillar shall depend on depth from surface and width of the gallery. Minimum pillar size is prescribed in the regulations.
4. Normally pillars shall be rectangular in shape.
5. No narrow main or advance heading (*mool*) shall be driven more than 3m ahead of the widened gallery.
6. Seam shall not be developed by u.g. method where hard cover over the seam is less than 7.5m. If hard cover is more than 7.5m but less than 15m, development shall be done with permission from DGMS.
7. No working shall be made within a distance equal to half the pillar size, for the depth from surface and a gallery width of 4.8m, from the **boundry** of the mine so that two adjacent mines have a barrier of one pillar.
8. Where work is done in more than one seam, barriers at the boundary shall, as far as practicable, be vertically coincident and of the same dimensions.
9. When development has be done within 60m of mine boundary, management of the adjacent mine shall be informed.
10. The following types of working shall not be done without prior permission from DGMS :
    (a) Working in more than one section in any seam.
    (b) Working in two seams or sections lying within 9 m of each other (contiguous seams/sections).

    (c) Working within 45 m of,
    - Railway, or
    - public works, or
    - public road, or building or other permanent structure not belonging to owner of the mine.

    (d) Vertically below or within horizontal distance of 15 m from a river, canal, lake, tank or other surface reservoir.
    (e) Within 60 m of a waterlogged working.
11. Where any working is extended to within 30m of any goaf or disused working containing or likely to contain an accumulation of inflammable or noxious gases, there shall be maintained at least one bore-hole not less than 1.5m deep in advance of the working.
12. No work shall be done is a seam at any place if the working in the lower seam may collapse.

Q. 2. (a) What is a panel? Describe provisions of the regulations regarding panel system of working.

(b) What are the advantages of panel system of working?

Or

Describe briefly 'working by panel system'. (2004)

Panel system

While developing a seam, sets of 5-7 galleries are driven which are separated from adjacent sets by a coal barrier, one pillar wide. These are known as panels.

Provisions of regulations

1. Every seam or section shall be so divided into a number of panels or districts, that each panel gets a current of fresh air from the main intake and has independent ventilation, so that any panel can be easily isolated from other panels.
2. Where development has already been done without making proper panels, artificial panels shall be made by constructing isolation stoppings.
3. Size of a depillaring panel shall be such that all pillars of the panel can be extracted within the *incubation period*.

4. Before commencing work of pillar extraction in any panel, firedams or isolation stoppings shall be constructed in every entry to the panel, except for those required to be kept open for ventilation or haulage. In these entries *preparatory isolation stoppings* shall be made, and bricks, sand and other materials for completing the stoppings shall be kept available nearby.
5. As soon as work of depillaring in a panel is completed, shall be sealed off by completing the stoppings.

Advantages of panel system

1. Every panel gets fresh air from the main intake airway.
2. As extraction of coal is completed and the panel sealed off within the **incubation period,** there is no danger of spreading of fire.
3. In the event of development of spontaneous heating in any panel, it can be **easily isolated** and the work of other panels is not disturbed.
4. **Airblast** in any panel does not affect other panels.
5. Since every panel is surrounded by a solid barrier of coal, possibility of **over riding of pillars** is eliminated.
6. Since work is done in panels each of which has a solid barrier around it, **subsidence** of surface is reduced.
7. Soon after completing development work in any panel, its depillaring work can be commenced—it does not have to wait for development of other panels. This minimises the problems of stability, ventilation, stone dusting and spontaneous combustion.
8. Supervision of work becomes easy.

Q. 3. Assuming your own conditions, describe the operations of a development panel to produce 400 tonnes of coal per day from a 3m thick degree II gassy seam.

Development of 3m thick seam by LHDs (Production 400 tpd)

Given

Seam thickness	3m
Gas degree	II
Production	400 tonnes per day

Assumptions

Dip of the seam	1 in 30
Gallary size	4.8m × 3m
Pillars	25m × 25m
Sp.gr of coal	1.3
Roof	fair, RMR 50

Method of work

Seam dip being mild (only 1 in 30), LHDs (Load Haul Dumpers) can be used. Layout of a 6 level panel is shown in the sketch. Development shall be extended in the strike direction.

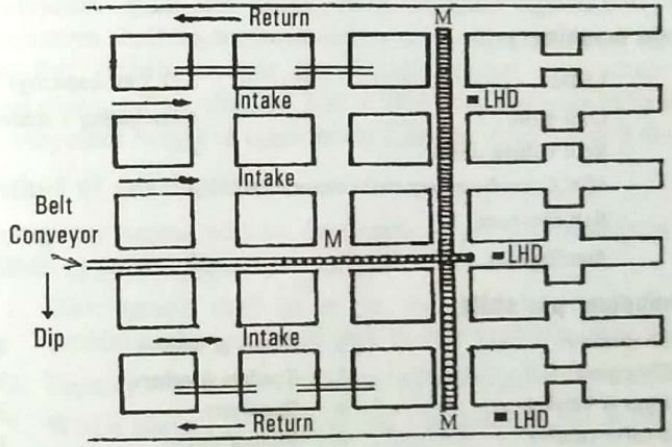


Fig : **Layout of LHD panel**

Blasting

Coal shall be extracted by solid blasting. P-5 explosive and delay detonators shall be used. Assuming blasting of one round of holes in every face in a shift, a face progress of 1.4m can be expected. On an overage the panel shall have 10 faces.

Coal per blast = width of face x height x progress x sp.gr of coal

= 4.8 x 3 x 1.4 x 1.3 = 26 tonnes

Daily production = 26 x 7 faces x 3 shifts = 546 tonnes

Taking an average of 80%, expected output 400 tonnes perday.

Support

After dressing, the freshly exposed roof will be supported by 1.5m long cement grouted bolts. Distance between bolts 1m, distance between rows 1m, distance of first row from the face 1.8m (maximum). At the junction, roof bolts will be installed at 0.8m intervals.

Loading and transport

For loading the blasted coal from faces, 3 LHDs will be used. LHDs will drop the coal on dip-rise MDCC (medium duty chain conveyor) which will be carried by the level MDCC to the belt conveyer. The belt conveyor will transport coal upto underground bunker. From the bunker a belt conveyor will convey coal to surface.

Main machinery

LHDs	3 (1.5 m^3 capacity)
Coal drills	4 (including 1 spare)
Roof bolting drills	4
MDCC (medium duty chain conveyor)	3
Belt conveyor	1
Auxiliary fan	1

Manpower per shift

LHD operators	3	Fitters & helpers	4
LHD helpers	3	Tyndels & others	16
Drillers & helpers	6	Shotfirers	2
Explosive carriers	2	Mining sirdar	1
Dressers	2	Overman	1
Support mistri	2	Foreman	1
Support mazdoors	2		59
Conveyor Khalasi	3		
Water spray/ cleaning mazdoors	4		
Pump khalasi	1		
Electrician & helpers	4		

Manpower per day = 59 × 3 = 177, Production 400 t

District OMS = 400 ÷ 177 = 2.3 tonnes

Note : OMS stands for output per man shift i.e. daily production per manshift.

Q.4 What are contiguous seams? Assuming your own conditions describe the method of development of contiguous seams.

Contiguous seams

When parting between two seams is less than 9m, they are known as contiguous seams. For developing both the seams at a time, or one by one, permission has to be taken from DGMS.

Development of contiguous seams

Assumptions : Upper seam 2.8m thick, lower seam 2.4m, parting between them 2.0 to 4.8m, dip 1 in 10 (about 6°), depth of the lower seam from surface 200m. Roof of both the seams consists of medium hard sand stone.

Permission shall be taken from DGMS. Application for permission shall be accompanied by mine plan, proposed layout and full details as per the DGMS format. According to regulations, pillars shall be 30m × 30m with 4m wide galleries, development height in upper seam 2.8m, in lower seam 2.4m.

Method of development

Contiguous seams will be developed as per the conditions of DGMS approval, which generally would be as follows :

1. Development shall be as per the approved layout. Panel barriers in the two seams shall be kept vertically coincident.
2. Development shall be pillar over pillar and gallery over gallery.
3. Where parting is less than 3m, coal shall be left in roof of the bottom seam.
4. To check coincident verticality and thickness of parting, boreholes or staple pits shall be made at alternate pillar junction in the level and dip-rise direction.
5. For convenience of ventilation, haulage, pumping and supervision, the two seams shall be interconnected by necessary number of staple pits/drifts.
6. Workings of both the seams shall be under charge of the same overman.
7. Any new face shall be opened only after the surveyor gives a centre line.
8. Surveyor shall carry out survey once a week.

9. Bottom seam workings shall be at least one pillar ahead of top seam workings.
10. Water of the bottom seam shall be pumped to the main sump in the top seam and from there to the surface. Coal of the top seam shall be dropped into ground bunker and then loaded on to the belt conveyor installed in the bottom seam.

Q. 5 Enumerate (a) Effects of faults on depillaring,
(b) Precautions to be taken during depillaring in fault area.

Effects of faults on depillaring

- Danger of detached roof falls, slips.
- Danger of premature fall.
- Tendency of subsidence to extend towards the fault plane.
- Possibility of large make of gas and water.

Precautions during depillaring in faulted area

- Quick action with small exposure of roof at a time.
- Only 2-3 pillars to be attacked at a time with diagonal line of extraction.
- Whole length of the fault not to be exposed at a time.
- Direction of face advance not to be parallel to the fault plane but at an angle.
- Coal barrier to be left on either side of the fault.
- Systematic support.
- Effective ventilation and careful checks for gas.
- Arrangement for dealing with water.
- Good stonedusting.
- Effective supervision.

Q. 6. A 4 m thick coal seam dipping at 1 in 2.5 is proposed to be developed by semi-mechanised method. Roof and floor consist of hard sand stone. Describe a method of work giving proposed machinery, manpower and supervision. Other conditions can be assumed. (2011)

Development of 4 m seam dipping at 1 in 2.5 by SDL

Given

- Seam 4 m thick, dip 1 in 2.5, roof & floor hard sand stone.
- To be developed by semi-mechanised method.

Choice of method, assumed conditions & decisions

- Semi mechanised development can be with LHDs or SDLs using chain or belt conveyors. LHD cannot be used because of steep dip. Floor is hard, hence SDLs can be used, but for SDL, floor gradient should not exceed 1 in 4.

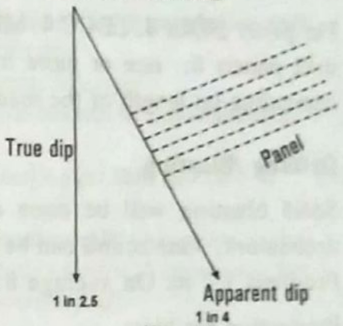


Fig : A

Therefore development will be done along apparent dip of 1 in 4. (fig. A)

- As per CMR, gallery width and height should not exceed 4.8 m & 3 m respectively. Therefore development will be done with extraction height 3 m along the floor, leaving 1m coal in roof. Gallery width will be limited to 4.5 m.
- Assumed pillar size 30 m x 30 m, gas degree I, specific gravity of coal 1.3 t/m^3. Required production 800 t/month. This will be obtained from two panels.
- Since seam is degree I, solid blasting can be done with permission from Regional Inspector.

Proposed Panel Layout

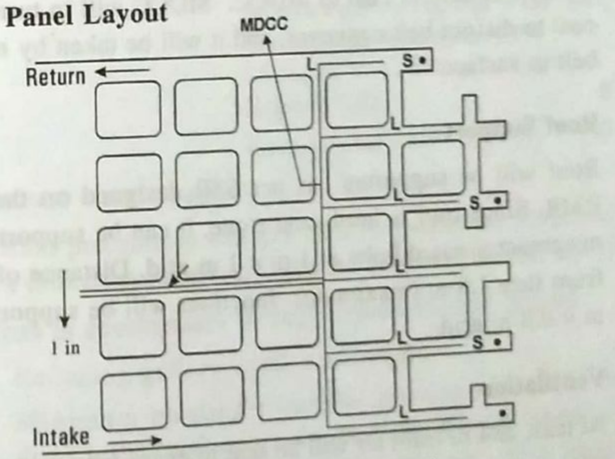


Fig : B 6 level SDL panel layout

S - SDL, MDCC - Medium duty chain conveyor, L - Light duty chain conveyor

Main machinery

Per panel SDLs 4, LDCC 4, MDCC 2, belt conveyor 1, drills 6, drill panels 6; one or more trunk conveyors will be required depending on length of the roadway.

Drilling /Blasting

Solid blasting will be done using P-5 explosives & delay detonators. One round can be blasted in every face per shift. Progress 1.2 m. On average 8 faces will be available.

Production per blast

= Face width × height × progress × specific gravity of coal

= 4.5 × 3 × 1.2 × 1.3 = 21 tonne

Daily production

Production per panel = 21 × 8 × 3 = 504 t, say 400 t taking into account breakdowns/delays.

Production from 2 panels = 800 t.

Loading & Transport

Blasted coal will be loaded by SDL and dumped into LDCC which will deliver coal to MDCC. MDCC will in turn transport coal to district belt conveyor, and it will be taken by main/trunk belt to surface.

Roof Support

Roof will be supported as per SSR designed on the basis of RMR. Since roof is hard sand stone, it can be supported by 1.5 m cement grouted bolts at 1 m × 1 m grid. Distance of first row from face 1.8 m (maximum). Junctions will be supported at 0.8 m × 0.8 m grid.

Ventilation

At least 284 m^3/min air will be sent to every face using auxiliary fan.

Manpower

Per panel per shift	
Drillers/helpers	12
Explosive carriers	6
Shotfirers	2
Dressers	2
Support gang	8
SDL operators	4
SDL helpers	8
Chain conv. operators	7
Belt conv. operator	1
Conveyor cleaner	4
Water spray mazdoor	2
Fan khalasi	1
Electricians/helpers	2
Fitter/helper/tyndels	6
Mining Sirdar	1
Total	**66**
For 2 panels (A)=58 x 2	**132**

Common for 2 panels per shift	
Overman	1
Under Manager	1
Total common for 2 panels/shift (B)	**2**
Total u.g per shift (C)= (A + B)	**134**
Surface/shift (Attendance clerk, Body searcher, Lamp room, fan operator) **(D)**	**5**
Mine total/shift (E)= (C+ D)	**139**
Total Production shifts (F)=(E x 3)	**417**
General shift maintenance	
Electricians'/helpers	6
Fitters/helpers	4
Cleaning/dusting	6
Lamp room	4
Others	6
Foreman	1
Elec. Supervisor	1
Total (G)	28
Manpower/day (H)= (F + G)	**445**
Managerial (Manager, Asstt Manager, V.O., Safety Officer, Engineer) **(I)**	**5**
Grand Total = (H + I)	**450**

OMS = 800/450 = 1.77 (approx)

Q. 7. What precautions will you take in gallery development in broken/disturbed and crushed ground? (2011, 2013)

Precautions in development through broken/crushed ground

1. Reducing gallery width and height.
2. Minimum blasting : Careful drilling so as not to disturb the roof, minimum number of holes, reduced charge per hole. Whole face may not be drilled/ blasted – drilling/blasting may be restricted to only a part

of lower portion and then size increased by dressing.

3. Good roof and side dressing.
4. Prompt support of freshly exposed roof.
5. Supports at short distances. Resin bolting or cross bars over cogs set on either side of the gallery. Insertion of cgi sheets over cross bars.
6. Use of fore poling, if required.
7. Avoiding formation of junctions in the crushed zone.
8. Tight supervision.

Development by Continuous Miner

Q. 1. Describe birefly the method of panel development by continuous miner and shuttle cars.

Development by continuous miner and shuttle cars

1. **Layout :** Layout of a 5 heading development district is shown in the sketch. The district has one continuous miner and 2 shuttle cars of 10t capacity with 200m electric cable. Shuttle car receives coal from the continuous miner and dumps it into the district belt conveyor through a feeder breaker. Feeder breaker limits the size of lumps and regulates the feed to belt conveyor.

2. **Method of cutting and support :** Cutter head of the continuous miner is 3.3m wide. The machine sumps in 0.5 to 0.75m at roof level, and then shears down to floor level. After advancing 4 to 6m, the machine is re-positioned to take the 2nd pass of 2.3m to form an overall gallery width of 5.6m. Gallery height is 4.5m (seam 4.5 thick). For large width and height special permission is taken from the DGMS.

   Continuous miner cuts 10m beyond the last row of roof bolts. Operator controls it remotely from under supported roof. Once the cut has been completed, continuous miner is trammed (place changed) to the adjacent heading to commence cutting cycle there. Simultaneously mobile roof bolter enters the first heading to install roof bolts. The bolter has 4 drills.

3. **Safety :** Continuous miner produces a lot of dust inspite of wet cutting.

A dust extractor is therefore mounted on the machine.

Ventilation is by forcing auxiliary fan.

No blasting is done.

Manpower required is low. All work is done from well supported roof.

4. **Production :** Total manpower : 100 for 3 shifts
   Production : 1200 t per day

5. **Machine utilisation time :** In view of high capital cost, a high machine utilisation time is essential. Manriding system shall be provided.

Note : The above system was first introduced in India in Anjan Hill mine of SECL. It is now being used in several mines.

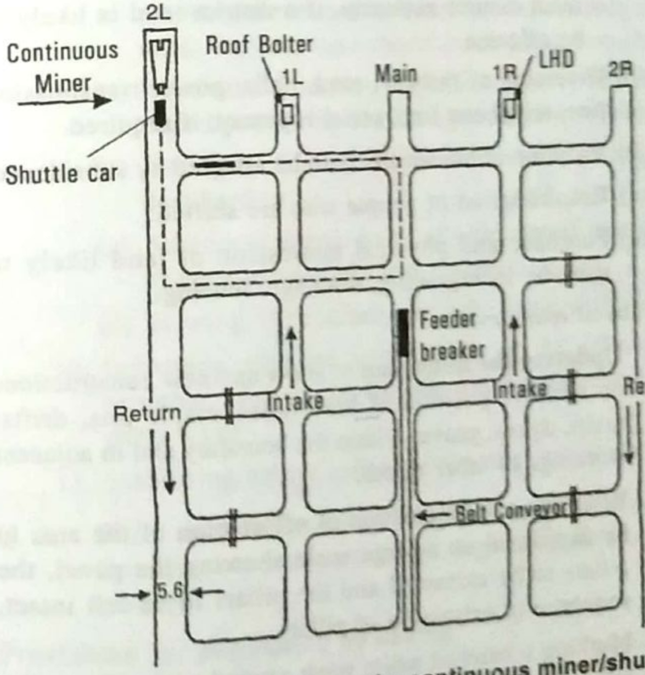


Fig: **Five heading development by continuous miner/shuttle cars**

Note : For description of continuous miner and shuttle car and their safety features, see chapter on 'u.g. face machinery'.

●

Chapter 6

DEPILLARING

Q. 1. Describe preparatory arrangements for depillaring.

Preparatory arrangements for depillaring

A. *Time consuming jobs involving outside authorities :*

(a) Obtaining permission
  - from Regional Inspector
  - from the Railway, if railway land is likely to be affected.
  - from district authority, if a district road is likely to be affected.

(b) Diversion of railway, road, nalla, power transmission line, telephone line, aerial ropeway, if required.

(c) Vacation of houses likely to be affected by subsidence.

(d) Rehabilitation of people who are shifted.

(c) Purchase and physical possession of land likely to subside; its regrading, drainage, fencing.

B. *Jobs at mine level*

1. **Updating the mine plan** to show any new constructions on surface; position of bore holes, staple pits, drifts; faults, dykes, goaves within the boundary and in adjacent workings of other mines.
2. Resurvey and preparation of **offset plan** of the area to be depillared on a large scale showing the panel, the pillars to be extracted and the pillars to be left intact, sequence of extraction of pillars.
3. Marking a band of white wash around each pillar to be left intact.
4. Sealing surface boreholes along whole length with concrete.
5. Dewatering of the upper seam, if it is water-logged.

6. Building isolation stoppings; building preparatory stoppings in roadways left open for ventilation and haulage, and reaching bricks, sand for closing the openings when depillaring in the panel is completed.
7. Preparing systematic support rules (SSR).
8. Geological mapping u.g. to mark areas needing advance support.
9. Making arrangements for :
   (a) Additional experienced mining sirdars, overmen; giving them handplans and copies of SSR.
   (b) Experienced supports men and dressers.
   (c) Timber, steel cogs, roof bolts and accessories.
   (d) Safety items : sylvester prop withdrawers, gas detectors, CO detectors, safety lamps, birds, methanometers, water spray line, stone dust, bricks, sand, cement, c g i sheets (corrugated iron sheets).
   (e) Extra tubs. Checking magazine capacity and haulage capacity as during depillaring production will increase.
   (f) Setting up first-aid stations, miners' stations, stone dust barriers.
   (g) Additional pumps–make of water would increase due to development of surface cracks.
   (h) Stowing, if depillaring is to be done with stowing.
10. Informing adjacent mines likely to be affected, for example, mine on the dip side which may have to pump extra water.
11. Stabilising outbye pillars by stowing or supports.

Q. 2. What are the methods of depillaring in an u.g. mine? Describe statutory provisions regarding depillaring by caving.

Provisions for depillaring by caving

There are two methods of depillaring u.g. :

- Depillaring by caving
- Depillaring with stowing

The provisions for depillaring with caving are as follows :

1. Permission will be taken from Regional Inspector, and conditions of approval shall be meticulously followed.
2. Work will be done after forming panels. Size of the panel will be such that all pillars of panel can be extracted within incubation period. Before commencing extraction, isolation stoppings will be constructed in all entries of the panel, except those required for ventilation and haulage. In these entries preparatory stoppings will be built, and adequate quantity of sand, bricks shall be kept available nearby to close the openings.
3. Pillars will be extracted as per planned extraction line. It will be such as will prevent extension of a collapse or subsidence of the goaf over pillars which have not been extracted (to prevent over-riding of pillars).
4. Splitting or reduction of pillars or heightening of galleries will not be carried out to a distance greater than length of two pillars ahead of the pillar under extraction. When pillar extraction is about to begin in a district, such splitting/heightening will be restricted to a maximum of 4 pillars.
5. Caving height will not exceed 4.5m or as permitted by Regional Inspector.
6. Area of uncollapsed roof will be kept as small as possible, with due regard to danger from air blast or weighting on pillars. Where possible, suitable means should be adopted to bring down the goaf at regular intervals.
7. Area under extraction and upto two pillars outbye (or 30m, whichever is greater) will be kept supported as per approved SSR. Goaf edge supports will be particularly strong.
8. Once extraction of a slice or stook is commenced, work will be done as fast as practicable, and soon after completion of extraction, supports shall be withdrawn to permit fall of roof.
9. No support will be left standing in the goaf. If for any reason a *chowkidar* or rib is to be left unextracted, it will be blasted so that roof comes down easily.

10. Strong supports shall be erected at the goaf edge to provider a breaker line so that,
    - Caving maybe better induced.
    - Excessive roof pressure may be avoided.
11. Convergence recorders and multi point extensometers etc. shall be installed as per Strata Control Plan.
12. On getting symptoms of fall of roof, all persons will be withdrawn to a safe place.
13. At all times, precautions should be taken against spontaneous heating. Samples will be drawn from return air of the district atleast once a week and analysed for CO.
14. Special attention will be paid to ventilation and gas checks.
15. As soon as work of extraction is over, the panel shall be sealed by closing the preparatory stoppings by masonary work.

Q. 3. What is a stook? What are the common methods of extracting stooks?

Stooks

In the process of depillaring, a pillar formed during development is split in 2 to 4 parts, depending on its size, to limit the area of roof exposure. These parts of pillar are known as stooks. Stooks are then extracted one by one. A stook can be extracted by 3 methods :

1. **Attacking the entire stook** (where roof is good) : Leaving a rib of 2m against goaf, the stook is extracted from two sides (sequence is shown in the sketch by 1,2,3). On return, the rib is thinned down as much as safety permits.

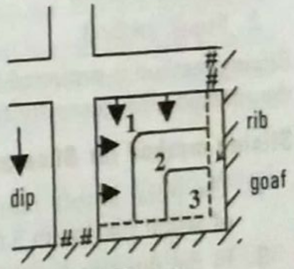


Fig : a

2. **Half moon method** (For good roof) : Stook is attacked in half moon fashion, leaving 2m ribs from the corner in half moon fashion. In the end, these ribs are thinned down as against the goaf. In the end, these ribs are thinned down as much as is safely possible.

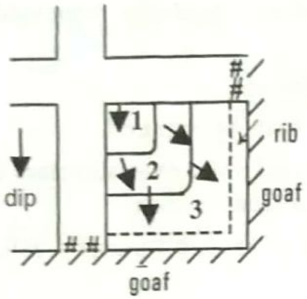


Fig : b

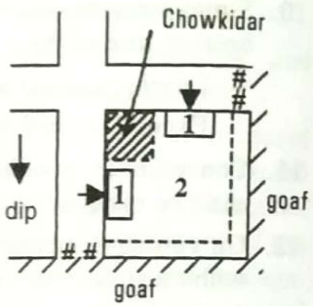


Fig : c

3. **Fender** (*chowkidar*) **method** (For bad roof) : Leaving a 10m × 10m fender at the corner, and a 2m rib against goaf, the stook is attacked from two sides. On return the ribs are thinned out as much as safety permits and in the end the fender is taken out by half moon method.

Q. 4. (a) What are the various methods of pillar extraction? Explain slicing method giving a sketch.

(b) How the method will change if extraction height is more than 3m and SDLs (Side Discharge Loaders) or LHDs (Load Haul Dumpers) are used in depillaring?

Slicing Methods

A pillar can be extracted by :

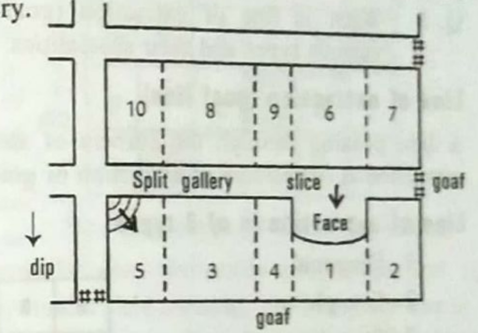
1. Slicing method
2. Stook method

Slicing method is preferred for bad or weak roof. In India, this is the method now generally followed.

Slicing method (or Slice and Rib method)

1. The pillar is split into two halves by driving a level split. of width maximum 3.6m.
2. In the dip side half pillar, a slice is driven from the split gallery leaving a 2m rib against the goaf. Width of slice is limited to 4.8m. Width of slice is so chosen that the area of roof exposure (i.e. slicing area, including the ribs and the split junction adjoining the slice) does not exceed $90m^2$. (or as approved by DGMS)

3. After driving the slice to full length, the rib is thinned down as much safety permits.
4. Before starting 2nd slice, supports of the first slice are withdrawn.
5. After completing 2nd slice, the remaining portion is attacked from the gallery.
6. If any rib cannot be extracted, it is weakened by blasting.
7. In one pillar, at a time only one slice is worked.
8. After completing extraction of dip side half, the rise side half pillar is similarly extracted.
9. At every stage, roof is supported as per systematic support rules.



Slices 1,3,6,8 are worked in the order shown

Fig : Pillar extraction by slicing

Slicing method for height exceeding 3m

1. If depillaring height is more than 3m, the slice in first driven to 3m height. Supports are set as work progresses.
2. Once the slice is driven to its full length, top coal is taken by blasting 1 to 1.5m portion at a time supporting afresh by taller supports. DGMS permits a maximum height 4.8m (at places only 4.5m).
3. The process is repeated till the entire slice is heightened. Rib is then reduced as much as is safely possible.
4. Supports are then withdrawn one by one. After setting goaf edge supports, the next slice is started.

Use of SDL/LHD

If SDL or LHD is used, DGMS permits a gallery height of 4.8m and a width of 5.4m. Rib is kept 2.5 to 3m thick.

Note : 1. A large pillar may be split into 3 parts instead of 2.

2. This method can be used also when depillaring is to be done with stowing.
3. In a mine having the problem of blackdamp, pillar may be split by dip-rise split, and slices may be worked towards the level.

Q. 5 What is line of extraction (goaf line)? Explain the various types and their specialities.

Line of extraction (goaf line)

A line passing through the corners of stooks or slices under extraction is called line of extraction or goaf line.

Line of extraction is of 3 types

1. Diagonal
2. Straight
3. Step diagonal

Diagonal line of extraction

It is a slanting goaf line making an angle of 45° with direction of dip of the seam. It is the most adopted line because it is a long line providing large number of working faces and stability. Every stook under extraction has an adjacent unworked stook by the side for support.

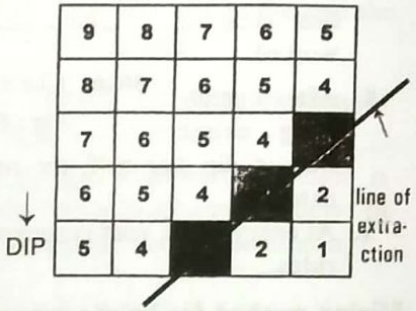


Fig : **Diagonal line of extraction**

Depending upon behaviour of the roof, any angle other than 45° may also be chosen.

Straight line of extraction

This line is along or at right angles to the direction of dip of the seam. A line along dip-rise is adopted where the roof is very hard and difficult to cave. Extraction line in the strike direction is used where roof is very reliable. It is very convenient when depillaring is done with stowing.

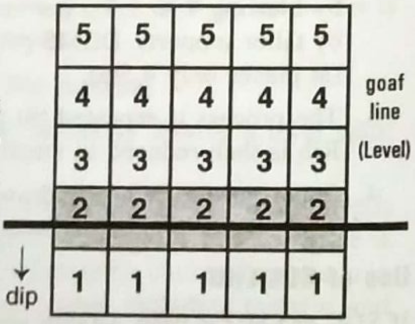


Fig : **Straight line of extraction**

Step-diogonal line of extraction

In this type, there is one solid stook between two stooks under extraction at a time. The solid stook provides support. Hence step-diagonal line of extraction is adopted where roof is weak. Step-diagonal line can also be so arranged as to have two solid stooks between two stooks under extraction.

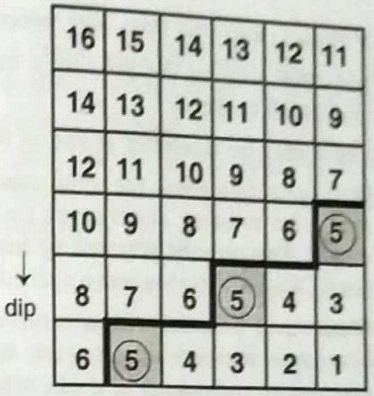


Fig : **Step-diagonal line of extraction**

In depillaring with hydraulic sand stowing, step-diagonal line is preferred as it facilitates water drainage without flooding workings in the lower level.

Q. 6. Why in a depillaring panel 'V' type line of extraction is not allowed?

'V' Line of extraction

If in a panel, coal extraction is started from two sides, two goaf lines are made, which join at a point in the form of letter 'V'. It is dangerous because at the V-point there is excessive pressure due to overlapping of abutment pressures and roof control becomes difficult.

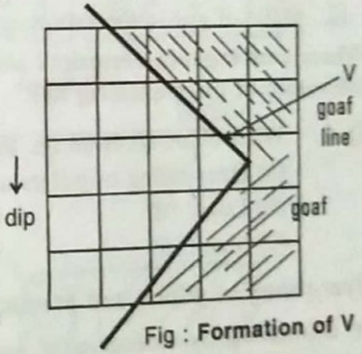


Fig : **Formation of V**

Q. 7. What are the indications of impending roof fall in a depillaring area?

Indications of impending roof fall in depillaring area

1. A prop in the working area on being tapped with a stick, gives a dull and drummy sound.
2. Lid over the prop may bend.
3. The prop may buckle or break in the middle or at a weak point in its length.

4. If floor is soft, the prop may penetrate it.
5. Indicator prop in the goaf may bend, or break or its lid may crack or bend.
6. There may be rumbling sound in the goaf.
7. Dust may fall from the roof cracks due to grinding of strata. An existing small crack in the roof may extend or widen. This may be detected by hammering a wedge in the crack. Wedge becomes loose and falls as the crack widens.
8. Water may percolate from roof when a crack develops. Flow may increase as the crack widens or it may totally stop due to movement of rocks which closes the crack.
9. There is an intermittent fall of rock pieces from roof in the goaf (scaling down of roof). Small coal pieces shoot off the pillar sides with bursting sound.
10. A booming sound may be heard from the goaf, with increasing frequency and intensity.
11. Floor may heave.
12. Make of gas in the face may increase.

Where **convergence recorders** are installed, they give a useful indication of the impending fall.

Q. 8. Write short notes on the following :

(a) Over-riding of pillars and premature collapse.
(b) Local fall
(c) Main fall

Over-riding of pillars and premature collapse

In depillaring by caving, after extracting a stook or slice the supports are withdrawn, roof in the goaf falls after some time. This is *normal collapse* which is expected and steps are taken to prevent danger to workers. *Premature collapse* is a collapse which is not expected and is therefore dangerous.

Massive sand stone or sill in the roof, immediately above the seam delays fall of roof in the goaf. When sufficiently large number of pillars is extracted, weight of the strata is transferred, before fall takes place, over pillars on the outbye side. If they are not strong enough, they may be crushed due to such sudden heavy pressure. This is known as *over-riding of pillars*. It results ultimately into premature collapse of the area.

Local fall

In a depillaring district, after supports have been withdrawn from an extraction area (stook or slice), the roof falls. This is called *local fall* as it does not extend to the surface and roof rocks upto only a few metres break and fill up the goaf. In well stratified sandstone or shale, local fall takes place in 24 to 48 hours after withdrawal of supports.

Main fall

When the goaf of a caving district extends over a large area (D^2 square metres where D is depth of the seam from surface in metres), fall in the goaf extends to the surface which cracks and subsides. This is known as *main fall.*

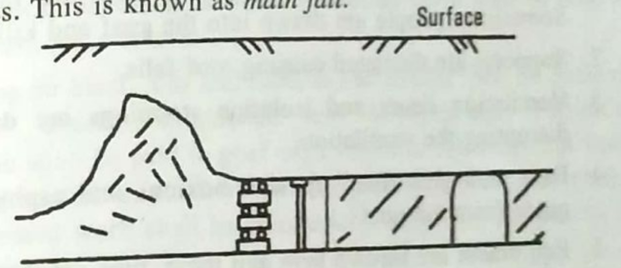


Fig : **Local Fall**

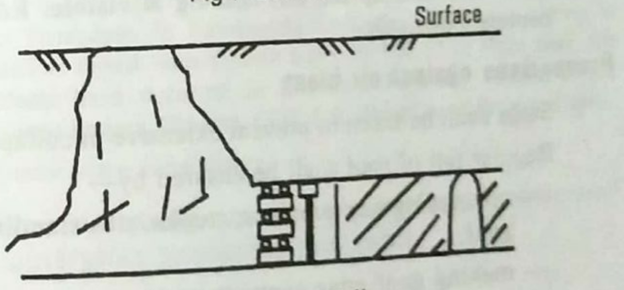


Fig : **Main Fall**

While local fall starts soon after starting depillaring, the main fall takes place much later. Main fall occurs at a comparatively short time if there is a fault nearby or the upper seam has already been caved.

Q. 9. (a) What is Air blast? Why is it dangerous?
(b) State the precautionary measures against Air blast.

OR

What are the causes of air blast? What precautions should be taken to prevent air blast accident. (2013)

Air blast

In a panel being depillared by caving, when roof in the goaf falls, air is pushed out from the goaf. Since the outlets are limited, air is pushed out at a high speed in the form of a blast. If the seam has a massive sandstone or a sill in the roof rocks, the goaf does not fall for a long time. When it becomes very large. it suddenly falls pushing out a large volume of air in the form of a strong blast of air. This is known as Air blast.

Dangers of airblast

1. People in direct path of air blast are thrown over long distances, some are killed by striking against the pillars. After an airblast, air is suddenly drawn into the goaf. Sometimes people are drawn into the goaf and killed.
2. Supports are damaged causing roof falls.
3. Ventilation doors and isolation stoppings are damaged disrupting the ventilation.
4. Face area gets filled up with noxious and asphyxiating gases from the goaf.
5. Equipment are thrown here and there, tubs get derailed.
6. Coal dust fills up the air, nothing is visible. Respiration becomes difficult.

Precautions against air blast

1. Steps shall be taken to prevent extensive uncollapsed roof.

   Regular fall of roof shall be ensured by—

   — not leaving any supports, stooks, ribs standing in the goaf,

   — making goaf edge supports strong,

   — following steep or straight line of face,

   — blasting down the roof, with special permission from DGMS.
2. A 1.5m × 1.5m part of every isolation stopping shall be kept open and covered only with a plastic sheet. These openings will work as safety valves when air blast comes.
3. A few shelters shall be made away from the direct path of air. These shall be supported by roof bolts, girders or cross bars and kept free of obstructions.

4. Nothing shall be allowed to lie loose here and there.
5. Before a massive roof breaks, roof movements in the goaf continue for 8 to 10 hours. During this period, coal getting operations may be kept suspended. Overman and mining sirdar shall listen to the roof movement sounds carefully. When fall is about to take place, they shall warn the workmen to retreat to the shelters. Power to the district shall be cut off, tubs shall be derailed, winding shall be stopped.

   Panels in which convergence recorders are installed, daily rate of convergence as compared to the average rate of convergence becomes helpful in predicting fall of roof.
6. Mock rehearsals shall be conducted from time to time to train the workers.

After the air blast, roof and sides in the district shall be dressed, supports checked, tightened and strengthened. Particular attention shall be paid to goaf edge supports. All stoppings shall be checked and repaired. Vulnerable places shall be checked for gas. Normal work shall be commenced only after the district is declared safe.

Note : Air blast killed 14 persons in West Chirimiri, 12 in Jamuria, 5 in Porascole. In Rawanwara Colliery, 14 persons sitting at incline mouth were thrown 6 to 60m and 11 of them died. Air blasts have occurred in Kottadih, Kuardih, Dhemo Main, Katras Project, Churcha, GDK-8 & 10 incline of Singareni also.

Utmost care is necessary.

Q.10. What is convergence? Describe briefly commonly used convergence monitoring instruments.

Convergence

Convergence is the reduction of distance (closure of gap) between roof and floor at any point. Rate of convergence gives an idea of efficacy of supports and an advance indication of fall of roof in the goaf.

For measuring convergence at any point, a peg is fixed in the roof and another in the floor vertically below it. The gap is measured by convergence measuring instrument. Difference in measurements from time to time gives convergence. Three simple types of instruments are given below

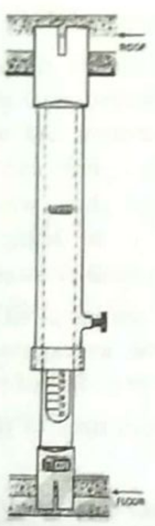


Fig : (a) Convergence indicator

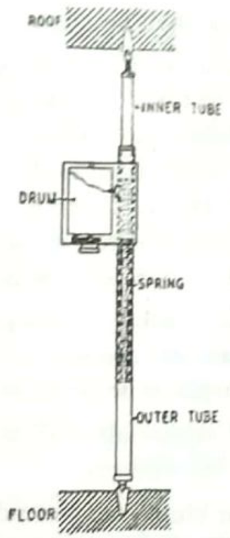


Fig : (b) Convergence recorder

Convergence measuring instruments

1. **Telescopic pipe convergence indicator.** It consists of a lower tube of bigger diameter in which the upper tube with spring below can travel. The upper tube is graduated and readings can be taken against a mark on the lower tube. An initial reading is taken between the roof and floor pegs. As faces advance, convergence increases , upper tube comes down and indicates the convergence that has taken place. Readings are taken at regular intervals to monitor the rate of convergence.

2. **Convergence recorder.** This is similar to convergence indicator described above, but a lever with ink pen holder is attached to the upper inner tube. A drum on the lower tube with a paper wrapped around it rotates by a mechanically wound clock. The pen records convergence on the paper.

3.**Telescopic rod type convergence indicator.** It consists of an upper tube inside which a close fitting graduated rod slides. The rod is painted with 1 mm graduations, which are highlighted by a reflecting tape for easy viewing. An initial reading is taken between the roof and floor pegs. Then readings are taken from time to time. Difference between the initial and a subsequent reading shows the convergence upto that time.

A single instrument can be used for taking readings at different fixed station points.

Q. 11. (a) What are the physical symptoms of impending fall of roof in goaf of a caving panel?
(b) Discuss the importance of measurement of convergence in caving panels.
(2014)

Physical symptoms of roof fall in goaf

- Weight on supports, buckling, bending, breaking of indicator props, props penetrating soft floor
- Fall of dust in goaf due to grinding of roof strata
- Coal pieces shooting off pillar sides with bursting sound
- Rumbling and booming sound of roof in the goaf
- Floor heave
- Change in water percolation
- Increase in make of gas
- Increase in sweating at the face.

Importance of convergence monitoring

Accidents in depillaring panels form a major part of accidents in underground mines.Many of these happen in caving panels due to failure in timely withdrawal of men in case of impending roof fall or air blast.

Correctness of mining sirdar/overman's decision depends on his experience and ability to interpret the physical indications of roof fall or air blast. Any error results in accident.

Measurement of total convergence or rate of convergence by an instrument :

- Gives clear indication of increasing roof pressure.
- Gives the mining sirdar/overman a scientific measurable basis for his decision along with the physical indications. This is likely to be more correct.
- Provides information for judging efficacy and adequacy of supports in the working area.
- Provides data for design of slice width, rib thickness, split width etc. in B&P working, and optimum face length & rate of advance in longwall working. This is utilised for modification in the working panel and for design of future panels.
- Provides data base for improving threshold values of daily convergence and total convergence.

DGMS now a days specifies measurement of convergence an essential requirement for extraction by caving.

Q. 12. (a) What parameters are monitored for ground control in mines and what instruments are used for the purpose?

(b) Discuss use of strata monitoring instruments in Bord & Pillar caving panel.

Parameters & instruments for monitoring ground behaviour

Important parameters and instruments for monitoring ground behaviour in mines are as follows :

Parameter	Instruments
1. Convergence	Convergence indicators, Convergence recorders
2. Dilation (separation of layers)	Bore hole extensometers (including rotary tell tales & auto warn tell tales)
3. Load on supports	Load cells
4. Stress on ribs/pillars	Stress meters

Some of these instruments can be of remote reading type also.

Use of monitoring instruments in B & P caving panel

In B & P caving panel, generally 3 types of instruments are used : (a) Convergence indicators, (b) Auto Warn Tell Tales, (c) Stress meters.

Convergence indicators. Convergence stations are fixed in every level upto 15 m from the extraction line at 5 m intervals. Convergence is measured at these station, using portable telescopic convergence indicator/rod, once every shift by shift under manager and in general shift by under manager (strata control). Readings are recorded.

As per CIMFR guideline, a fall in the goaf is indicated when C_1/C_2 ratio is 2 or more,

where C_1= convergence at a station on day n

C_2= average daily convergence upto the previous day i.e. upto day (n-1).

Based on practical experience, some mines in Singareni Coalfield use the criteria that if 2 mm convergence continues for 3 days, fall can be expected, and persons are withdrawn considering also the physical indications. Studies in another group of mines have shown, fall is expected when **daily rate of convergence** reaches 4 mm or **cumulative convergence** reaches 20 mm. Convergence accelerates fast within 2-3 hour period immediately preceding a roof fall.

Auto warn tell tales. Auto warn tell tales are installed at every original gallery junction and at every split level junction upto 2 pillars of pillar under extraction. The instrument is fitted in an upward hole in the roof – anchor going upto the desired height (10-15 m) with sensor at the hole mouth. It measures strata dilation (separation of layers/joint opening). The instrument is factory set to give warning by flashing its LEDs at 5 mm reading. A fall in the goaf is expected at 10 mm reading. Auto tell tales are particularly helpful in case of main fall. Special attention is paid when area of standing goaf reaches 5000 to 10000 m^2, depending on local conditions.

Stress meters. Stress meters are placed in pillar sides at 100 m, 200 m & 300 m distance from the extraction line. Readings are taken daily. They help in predicting the time of main fall.

Scheme of strata monitoring. For strata monitoring there is no pattern or threshold value universally applicable. For every individual mine/panel, a scheme of strata monitoring is drawn. It includes type of instruments to be used, pattern of installation, threshold values, persons responsible for reading/recording the values and actions to be taken when threshold value is reached. The scheme is based on field experience considering cavability of roof rocks, depth of working, size of panel/ pillars/galleries/ slices, sophistication of the instruments . In many cases help is taken of an expert agency like CIMFR.

Note :

1. In some mines, instead of auto warn tell tales, **rotary tell tales** of mechanical type are used. They show dilation by colour band on the telescopic rod and by pointer on a dial face.
2. Convergence in longwall workings follows more or less a predictable pattern, but it could be erratic in B & P extraction because of ribs/stooks left over in the goaf. Experience shows that continuous monitoring system provides reliable real time picture of events. Readings taken at intervals fail to evaluate critical values.
3. Strata monitoring instruments are of particular use in

longwall, continuous miner and blasting gallery panels. In a longwall panel, the pattern may be :

(a) Convergence stations at 5 m intervals upto 30 m from face in main & tail gate roadways,

(b) 3 Auto warn tell tales in every gate roadway at 10 m intervals,

(c) 2 load cells at 10 m interval in each gate roadway (fitted in open circuit hydraulic props),

(d) 3 stress meters in each gate roadway at 100 m, 200 m, 300 m from the face.

Q. 13. Describe an Auto Warn Tell Tale.

Auto Warn Tell Tale

It is a type of single height intrinsically safe extensometer. Goaf falls are preceded by small scale roof dilation. Tell tale is installed in roof of caving panel near the extraction line in an upward hole drilled upto a depth of 10-15 m (depending on length of its probe wire). It detects roof dilation and when dilation exceeds the preset value, it gives visible warning of impending fall of roof in the goaf by flashing its LEDs, in addition to showing it by colour bands on its rod. The LEDs are fitted to the underside of the plastic drip tray and powered by a dry cell located in the plastic moulding along with electronic module.

Fig : **Auto Warn Tell Tale**

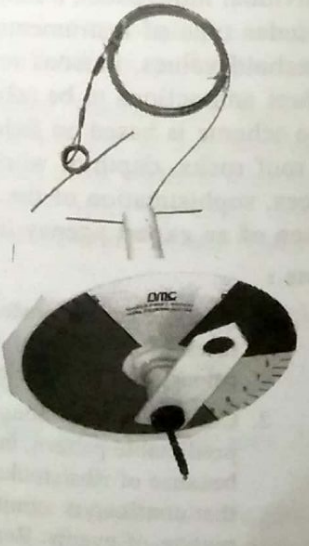


Fig : **Rotary Tell Tale**

The instrument is factory set to give warning at 5 mm dilation. LEDs continue flashing until the battery is exhausted (at least one week).

Auto warn tell tales are being used in mines of ECL, WCL, SECL & SCCL.

Note :

> Auto warn tell tale is a modified version of **'Rotary tell tale'** which is of mechanical type. Rotary tell tale converts roof dilation into rotation of a pointer round a dial and magnifies the movement 15 times. The dial face is sub-divided into coloured bands corresponding to chosen trigger level , for example green shows dilation 0 – 5 mm, yellow zone 6 – 10 mm, red zone 11 – 25 mm.

Q. 14. What is a bump? Give a brief description of various 12 types of bumps.

Bump

Bump is a sudden violent burst of a large quantity of coal from pillars, accompanied by loud sound, due to sudden release of elastic strain energy stored in the pillars. It may be accompanied by release of large quantity of gas also. Bumps generally occur in deep mines.

Bumps are of two types :

Pressure bumps, and

Shock bumps.

Pressure bumps : When roof in the goaf does not fall but keeps hanging over a large area, the pressure compresses the outbye pillars to some distance. As area of hanging goaf increases, compression of the coal pillars also increases. A stage comes when the pillars cannot compress further, and their stored strain energy is suddenly released in the form of violent ejection of large quantity of coal from the pillars. This is called pressure bump.

Shock bump : When roof of goaf does not fall, it keeps on hanging as a cantilever. When area becomes sufficiently large, the roof cantilever suddenly breaks. With this the outbye end of cantilever strikes on the pillars. The pillars are unable to stand this pressure and a large quantity of coal is suddenly ejected violently from the pillar. This is shock bump.

Bumps occur in thick seams with massive sand stone roof and lying at depth of over 240m. Example-Dishergarh seam in Raniganj coalfield. In the past, bumps had resulted in death of 13 persons in Sodeper.Colliery and 12 in Dhemo main colliery.

Q.15 What dangers are associated with the following and what precautions are necessary?

(a) Development in a seam over a caved lower seam
(b) Extraction by caving in a seam below a caved upper seam
(c) Extraction in a seam below surface features.

(2006)

Development over caved seam

Dangers & difficulties

1. Difficulty in haulage and movement of machinery due to change of floor gradient from place to place.
2. Difficulty in roof support due to fracture in strata.
3. Leakage of ventilation due to cracks in floor.
4. Eruption of black damp from the lower seam.
5. Danger of entry of water from goaf of lower seam.

Precautions

1. Commencing work in the upper seam only after the lower seam goaf has settled. Goaf may take 3-5 years to settle.
2. Work in upper seam only if parting between the seams is adequate. (more than 12 times the extraction height in lower seam).
3. Forced ventilation system.
4. Extra care in gas detection.
5. Use of main and tail haulage.
6. Manual loading of coal as deployment of SDL/LHD is difficult.
7. Pumping of water from the lower seam.
8. Special care in roof support.

Extraction below caved seam

Dangers

1. Danger of inundation by water from upper seam.
2. Difficulty in roof control.
3. Quicker and faster main fall.

Precautions

1. Allowing the upper seam goaf 3 to 5 years to settle down before commencing work in the lower seam.
2. Keeping upper seam goaf dry by continuous pumping of water.
3. Special care in support. Use of convergence recorders.
4. Immediate withdrawal on men on getting indications of fall of roof.
5. Supervision by experienced mining sirdar/overman

Extraction below surface structures

Dangers

1. Cracks in surface structures and chances of damage.

Precautions

1. Taking DGMS permission.
2. Leaving protection pillars below the surface structures and area around it upto the angle of draw.
3. Limiting width of extraction to less than non-effective width.
4. Marking every protection pillar by a band of white paint all around.
5. Fixing blasting pattern and charge per hole based on scientific studies by a research organisation.
6. Preparing and maintaining surface subsidence plan.
7. Regular inspection of the surface and surface structures.

Q. 16. (a) Explain what is induced caving and how it is done.

(b) What safety precautions are taken in induced caving by blasting? (2011, 2012)

Induced caving

Induced caving is the technique of inducing the fall of overhanging roof in the goaf of depillaring by caving panel.

Where coal seam is overlain by hard and thick layers of massive stone, roof in the goaf does not come down easily after withdrawal of supports. Large area of hanging roof , when it does fall, may cause air blast and overriding of pillars.

Methods of induced caving

(a) **Hydro fracturing.** Hydro fracturing involves drilling of long holes from surface upto the roof strata and creating fractures in the hard roof strata by hydraulic pressure by pumping water into the holes at high pressure. This method is limited to seams situated at shallow depth. Also the time of fall is unpredictable.

(b) **Induced caving by blasting.** When area of hanging roof in the goaf becomes large and load on supports increases, 5-6 m deep holes rising at about 45° and at intervals of about 1 m are drilled in one or two rows into the roof along the line of extraction about 3 m back from the goaf edge. Holes are charged with P-1 or P-3 explosives and instantaneous detonators. This induces the roof to fall or it becomes fractured so that caving can be controlled. In some mines, induced blasting is done first soon after commencing depillaring, along the panel barrier to create a line of fracture, and then blasting is done along the line of extraction from time to time.

Induced caving by blasting is the more preferred and commonly used method.

Safety precautions in blasting for induced caving

1. The method is used in degree I gassy seams only as there is danger of gas explosion.
2. Hole pattern is designed on scientific basis considering nature, strength and thickness of hard strata, to keep ground vibrations within safe limit.
3. Only permitted explosives and instantaneous detonators are used.
4. Before charging, depth of holes is checked. If any hole is found choked or jammed, quantity of explosives is adjusted accordingly.
5. Goaf edge supports are strengthened before commencing drilling.

6. Before blasting, all men are withdrawn to a safe place in another panel.
7. Checks are made for inflammable gas before and after blasting.
8. Ground vibrations generated are measured, and a record kept.
9. After blasting, normal work is resumed only after ensuring safety by roof/side checking, dressing, support checking/ tightening.
10. A record is kept of readings of convergence recorders.
11. In blasting along the barrier pillar, the nearest hole is drilled at least 4 m from the barrier to prevent damage to the barrier.

Q. 17. Giving a brief description, explain why –

(a) In a depillaring by caving district, extraction of pillars is started from the dip/inbye most end and continued systematically towards the rise/outbye end keeping diagonal or step-diagonal line of extraction.

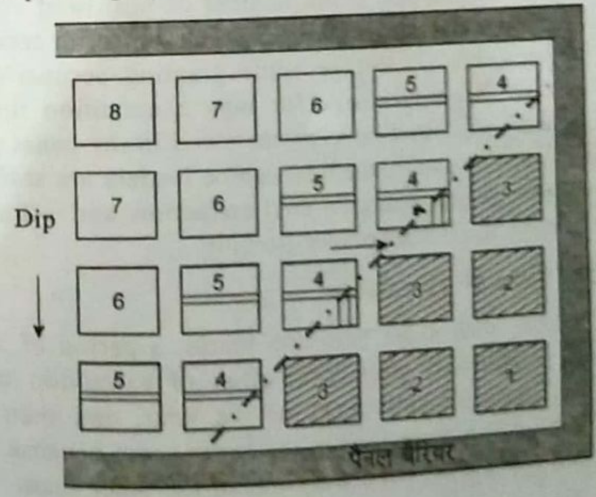
(b) In a depillaring with stowing district, there will not be more than two voids unstowed at any time.

(c) As far as possible, the lines of extraction in upper and lower seams/sections are kept coincident.

(2012)

Maintaining line of extraction

In a depillaring by caving district, pillar extraction is commenced



from the dip/inbye-most end and progressed towards the rise or outbye-end, maintaining diagonal or step-diagonal line of extraction.

For this purpose the overman is given a plan of the panel showing the sequence of extraction – as in the figure above from pillar no. 1 to pillar no. 8.

Reasons for following this method :

- Roof in the goaf will fall easily and not remain hanging, because it will provide a long line of extraction and major portion of load of the hanging goaf will act towards the dip.
- Roof load on ribs/slices and supports in the working places will be limited due to being distributed over several pillars.
- Pressure of caving goaf will not fall on pillars which are yet to be attacked.
- Debris of caving roof will fall towards the dip, and not encroach the working area.
- Blackdamp and water will fill from the dip side and not affect the working area.
- Air coursing, movement of men & machinery will be easy.

Limiting the number of voids in stowing panel to two

In a stowing panel, stowing sometimes lags due to shortage of sand or water, breakdown or jamming of the stowing range etc. Because of this voids ready for stowing remain unstowed. Experience has shown that if the number of unstowed voids in the panel exceed two, roof strata sag excessively and create the danger of instability. Therefore while granting permission for depillaring, the Regional Inspector lays a condition that not more than two voids shall be kept unstowed in the panel at any time. When such a situation arises, some loaders are shifted to another panel to reduce speed of coal extraction, and efforts are made to remove the bottleneck in stowing.

Coincident lines of extraction

- In a mine with more than one seams, a period of 3 to 5 years is allowed after completion of extraction of the upper seam for settlement of the goaf, and then only extraction is commenced in the lower seam because work in one seam affects the workings of the other seam.

- If parting between two seams/sections is 9 m or less, they are known as contiguous seams/section.
- If the line of extraction of the lower seam/section of two contiguous seams/sections is kept advanced, upper working will lie over goaf of the lower workings and the affected/ cracked floor will present problems in support. This will be dangerous.

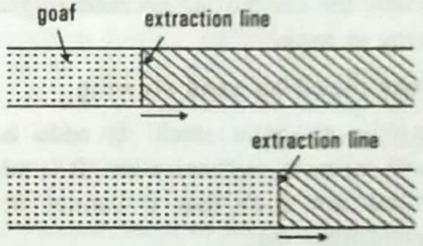


Fig : (a)

- Because of above reasons, Coal Mines Regulations stipulate that DGMS may permit simultaneous extraction of two contiguous seams/section provided-
  - Their pillars and galleries are superimposed,
  - Parting between seams/sections is 3 to 6 m
  - Lines of extraction in the two seams/sections will be maintained vertically coincident, as far as possible.

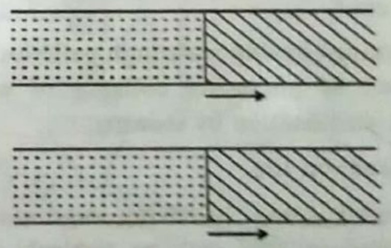


Fig (b) : **Coincident lines of extraction**

Q. 18. Discuss the importance of diagonal line in depillaring panel. (2014)

See Q. above.

●

Chapter 7

SAND STOWING

Q. 1. Describe the conditions necessitating adoption of sand stowing in mines.

Circumstances requiring sand stowing

Sand stowing is an extra work. It adds to cost, hampers production and restricts mechanisation. It is adopted only when mine conditions are such that it cannot be avoided. Such compelling conditions are :

1. Thick seam to be worked in lifts.
2. Surface features like built up areas, river, railway road to be protected.
3. Coal liable to spontaneous combustion.
4. Seam below a water logged upper seam or below water bearing strata.
5. Seam liable to airblast and bumps due to hard and difficult to cave roof.
6. Old workings having wide/high galleries and weak pillars; likelihood of premature collapse of workings, needing advance stabilisation by stowing.
7. Upper seam on fire.
8. Seam highly gassy. In caving large quantity of firedamp accumulated in goaf may be suddenly expelled into the workings.
9. Necessity to conserve coking coal. Stowing permits better percentage extraction of coal.
10. Necessity to form a barrier against a fire area.

Q. 2. Explain briefly arrangements made at the mine for sand stowing.

Arrangements for sand stowing

1. Supply of sand and water

Sand is collected at the river bank and brought to the colliery sand bunker by haulage, contractors' trucks or by aerial ropeway. Supply of water is obtained from water pumped out from the mine. Any shortfall is made up by pumping water from the river bed.

2330

2. Sand bunker and water tank

Sand bunker is made at surface of the mine at a place on rise side of the area to be stowed so that sand-water mixture can flow by gravity. It has a capacity of about 24 hours sand requirement. Sand from the bunker drops through a chute into the mixing cone (an inverted cone) fitted below the floor of the bunker. Flow of sand is controlled by controlling the opening of the chute. 24 hours requirement of water is stored in water tank at the surface, and it is taken by a pipe range to the mixing cone.

In rainy season, sand collection from river bed is difficult. Extra sand is, therefore, collected at a place nearby and brought to the bunker during the rainy season by trucks.

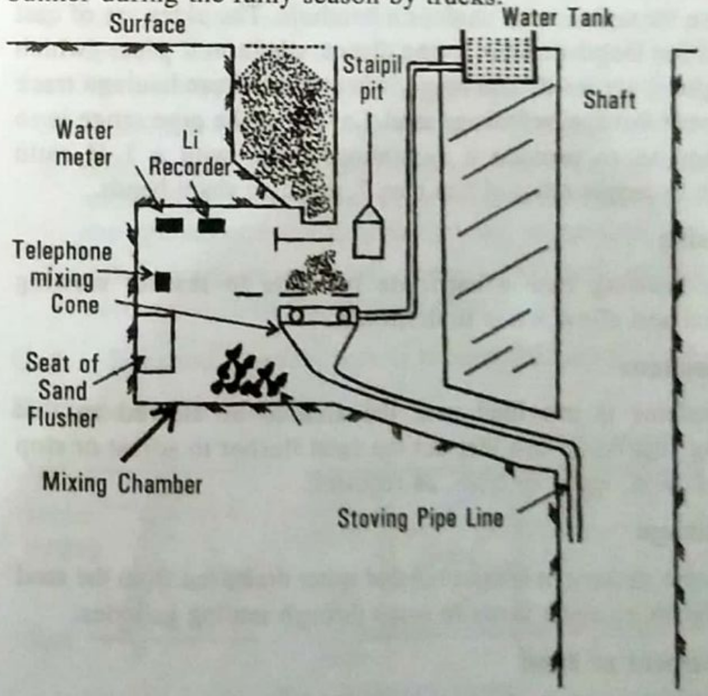


Fig : outline of sand stowing plant

3. Mixing chamber

The place where mixing cone is located is called mixing chamber. Mixing cone has a circular perforated pipe to which water is supplied from the surface tank. Here sand-water are thoroughly mixed and the mixture flows out from mixing chamber into stowing pipe range. A screen over the mixing cone prevents pebbles and stones going down with the sand-water mixture. These rejects are lifted to the surface from time to time.

Mixing chamber is provided with a water meter and LEA recorder for measuring water and sand respectively, a telephone for communication with stowing supervisor, a seat for sand flusher, and good arrangement for lighting and ventilation.

Approach to the mixing chamber is by a staple pit or a steep drift from the surface. In modern plants sand-water are mixed in a mixing trough which has automatic controls for sand and water.

4. stowing pipe range

A 125 or 150mm dia stowing pipe range carries the sand-water mixture through a mine shaft or a borehole. The pipes are of cast iron in 3m lengths except in the distict, where m.s. pipes (which are lighter) are used. The range is kept away from haulage track to prevent damage by leakage sand. Layout of the pipe range is so designed as to provide a continuous drop, with a L-H ratio (length to height ratio) of less than 7, avoiding sharp bends.

5. Boxing

At the stowing face a barricade in made to restrict stowing material and allow water to drain out.

6. Telephone

A telephone is provided near the area to be stowed so that stowing supervisor can instruct the sand flusher to adjust or stop flow of sand, water or both, as required.

7. Drainage

For proper packing, it is essential that water drains out from the sand pack. Drainage water flows to sump through settling galleries.

Requirement of sand

1.3t of send is required for every t of coal extracted from virgin area. In depillaring, it depends on percentage of coal taken during development. But on a rough estimate it may be about 1.8 t of sand per t of coal production. Sand-water ratio by volume may be about 1 : 1.5, which works out to about 935 litres water per t of sand.

Stowing is generally done in 2 shifts per day, average stowing rates being 100 to 150 tonnes of sand per hour of stowing time. In good installations rates of 500-600 tonnes per hour have been achieved.

Q. 3. For stowing what arrangements are made at the face?

Arrangements at the face for stowing

1. As soon as a stook or slice is extracted, boxing (barricade) is erected.
2. Supports are opened, but some supports are left in the area for safety of stowing gang. These will be opened as stowing is done and pipes are opened.
3. Old boxing is opened out.
4. Stowing pipe range is extended to the area to be stowed keeping the pipe mouth 5-7m from the dip side barricade. Pipe is supported on wooden cross supports.
5. Telephone is shifted near the area to be stowed.
6. Sand flusher is directed to open water. After 5-7 minutes when clean water flows, he is advised to open sand. Pipes are opened one at a time as stowing progresses.
7. After stoppage of sand, water is allowed to flow 5-7 minutes to clean the stowing pipe range.

Q. 4. For sand stowing, how is boxing (barricade) made?

Methods of barricading

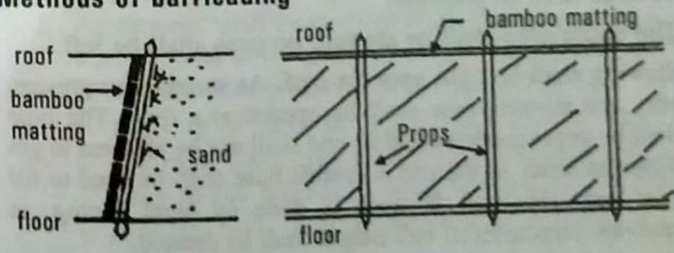


Fig : Ordinary boxing

Ordinary barricading : A barricade is usually made by erecting props at an interval of 1.2 to 1.5m along the periphery of the area to be stowed and nailing bamboo matting (one or 2 layers) or hessian cloth to the props. The props are erected in such a way that their top ends lean towards the goaf at an angle of about 10°. This makes opening of the boxing easy. In some cases of longwall stowing telescopic rails have been used instead of wooden props.

End boxing or dip side boxing : The dip side boxing or boxing adjacent to the drainage level is made specially stronger to prevent bursting. Cogs are erected at intervals of about 3m and wooden rollas inserted horizontally between adjacent cogs. Some rope strands are also inserted vertically to give further strength. Two layers of bamboo matting and two layers of brattice are nailed.

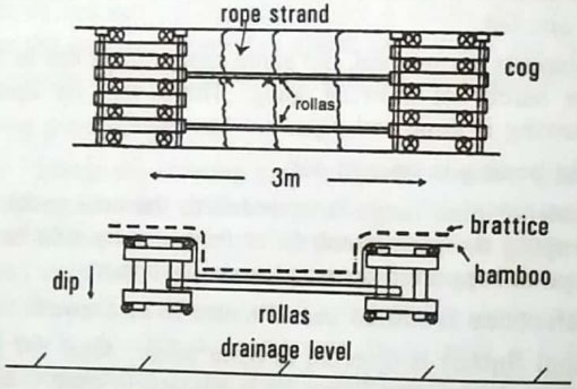


Fig : **Dip side boxing**

Q. 5. To what points should the mining sirdar/overman pay attention for stowing in the district?

Supervision of stowing by mining sirder/overman

1. After a slice or stook has been extracted, stowing shall be done as soon as possible.
2. The entire area shall be stowed, no gaps shall be left.
3. Stowing shall be tight upto the roof. As stowing progresses, only one stowing pipe shall be opened at a time. The pipe shall be kept supported and its end shall not be allowed to get buried in sand. At the end a flexible hose shall be used to fill gaps near the roof. If work is done by level slicing, at intervals barricades of half height shall be erected.
4. Boxing shall be made strong so that it does not burst.

5. Frequent starting/stopping shall be avoided. Stowing shall be commenced only after ensuring adequate stock of sand and water in the sand bunker, water tank respectively. Supports shall be withdrawn timely and any odd material lying inside the boxing shall be removed.
6. Proper arrangement shall be made for drainage of stowing water.
7. Pipe range shall be cleaned by running only water for 5-7 minutes at the beginning and end of stowing.
8. Goaf edge shall be kept-supported by cogs. A few props shall be left inside the boxing for safety of pipe fitters.
9. Telephone shall be kept near the area to be stowed for quick and easy communication with sand flusher.
10. Boxing shall not be made very wide; wide boxing requires extra water for spreading the sand.
11. Leakage in stowing range shall be dealt with promply.

Note :
1. Once a month the manager sends a 'stowing lag' report to Regional Inspector.
2. It is essential that the surveyor measures area stowed correctly from offset survey. After Godavari Khani (Singareni) disaster in June 2005, it has been decided that before a panel is sealed, overman and asstt. manager (in addition to surveyor) shall certify that stowing has been done completely, and no gaps have been left.

Q. 6. How will you arrange to release sand stuck up in the bunker?

Precautions in releasing stuck up sand

If bunker is well designed, normally there should be no need for a person to go inside the bunker to dislodge sand. But in some old sand bunkers sometimes it may become necessary to send a man inside the bunker to dislodge stuck up sand.

In such a case, the following precautions shall be taken :

1. An attempt shall be made to dislodge the sand by directing a jet of water or by operating a rake from outside the bunker.
2. If it is absolutely necessary to send a man in :
    - Work shall be done in day-light hours only.
    - A strong steel rope shall be anchored on surface and hung in the bunker to provide necessary hand hold.
    - A safety belt shall be used after checking it.
    - Work shall be done in constant presence of the overman.

– If U-brackets are provided in the bunker sides, these shall be used as steps.

Q.7. Give an outline of different methods of depillaring with stowing.

Depillaring with stowing

The methods of depillaring with stowing following step-diagonal goaf line, straight goaf line and keeping longwall faces are given below :

1. **Depillaring with stowing with step-diagonal face** : Depillaring with stowing is not much different from depillaring by caving. Here also the pillar is split into 2-4 stooks depending on its size, and the stooks are extracted maintaining a step-diagonal goaf line as shown in the sketch.

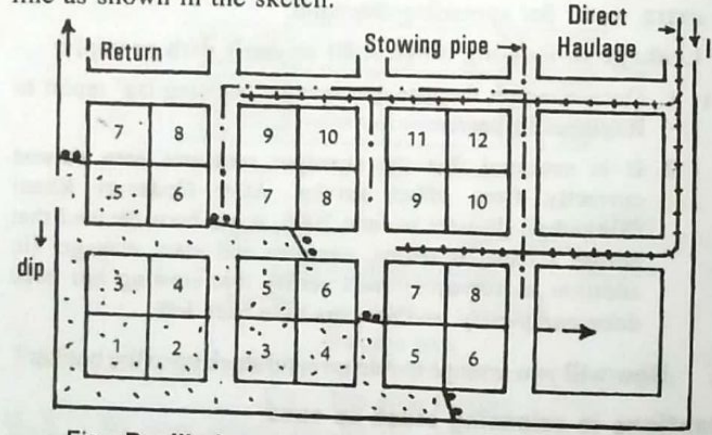


Fig : **Depillaring with stowing : step-diagonal goaf line**

Stook is extracted leaving about 1.5m ribs against the goaf, which are then thinned out as much as possible. The area is supported as per systematic support rules as extraction progresses. After completing extraction in a stook, supports are withdrawn. Barricades for stowing are erected by nailing bamboo mats or hessian cloth to props. Stowing range is extended to the boxing and the stook area is stowed. If instead of stooking, slicing method is used, each slice is extracted and stowed before starting the next slice.

2. **Depillaring with stowing with straight goaf line** : This method is used where the roof is strong and reliable. Here the pillar is split into two halves by driving a dip-rise split, Each half is extracted by slicing method, taking several stooks together as shown in the sketch. Area of exposure is limited to about 80 m^2 or as permitted by the DGMS. Supports are set during extraction. Thin slices are taken. After 3-4 slices, the area is stowed. Stowing pipe range is extended, stowing barricades are erected. Supports are withdrawn and stowing done.

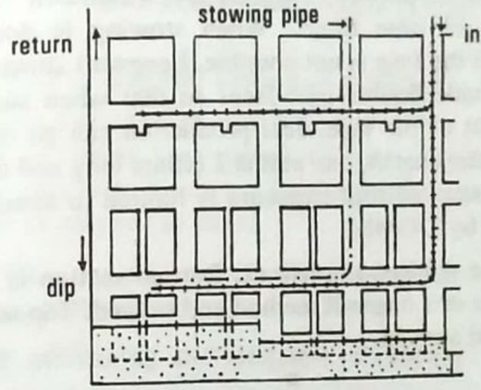


Fig : **Depillaring with stowing : straight goaf line**

Depillaring by longwall stowing method : Sometimes a coal seam is developed by Bord and Pillar method, but it is depillared making a longwall face as shown in the sketch.

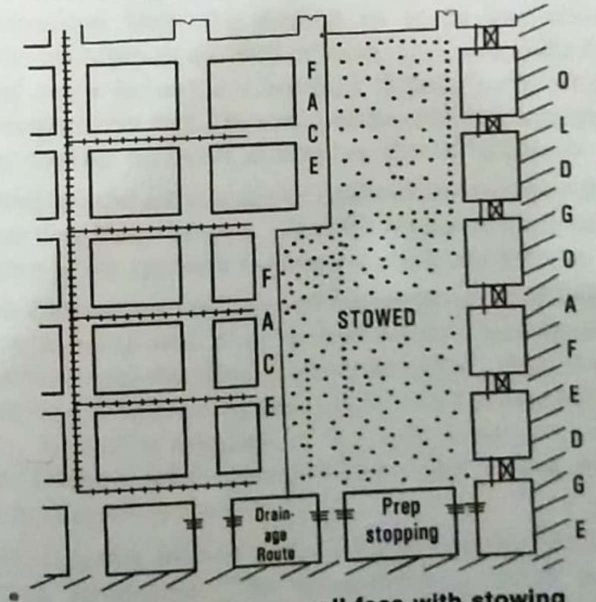


Fig : **Double unit longwall face with stowing**

Coal is extracted by blasting a 1 to 1.2m slice in 2-3 pillars at a time maintaining a longwall face. The area is supported as per systematic support rules as coal is extracted. After 4 to 5 slices have been taken, boxing is made, stowing pipe range is extended upto the area to be stowed, supports are withdrawn leaving a few for safety of pipe fitters. When stowing is done, coal production from the face is not possible. Longwall stowing faces are therefore made double unit faces so that when stowing is done in one unit of the face, coal production can go on in the second unit. In the sketch, one unit is 2 pillars long and the other 3 pillars long. Area of roof exposure is limited to about 80 m^2 or as permitted by DGMS.

Thick seams are worked is sections. Bottom section is worked by Bord & Pillar or Longwall method and stowed. Top section is then worked and stowed.

●

Chapter 8

LONGWALL METHOD

Q. 1. What is longwall method of working?

It is a method of underground mining, in which coal is extracted from 60 to 200m long faces, moving continuously in one direction over large distances, leaving behind the goaf. The goaf is packed or allowed to cave.

Q. 2. What are the major types of longwall method? Which method is more popular and why?

Longwall advancing and longwall retreating

There are 2 variants of Longwall method :

- Longwall Advancing
- Longwall Retreating

Longwall Advancing : In longwall advancing, extraction of coal commences from the vicinity of shafts and advances towards the boundary of the mine or panel. Approach to the face is by parallel roads formed at a specified distance apart, which is equal to length of the face. The roof over the extracted area (goaf) is packed by sand (or packwalls of stone) or allowed to cave in.

The method has the advantage that coal extraction can be started soon after reaching the coal seam by shafts or inclines. But maintenance of the approach roadways is costly and difficult.

Longwall Retreating : In longwall retreating, pairs of headings are driven in solid coal at an interval equal to pre-determined length of face upto the mine or panel boundary. Here they are connected by a long roadway one side of which is then used as a long face. As coal is extracted on this face, it *retreats* towards the shafts. Hence it is called longwall retreating method. Roof in the goaf is allowed to cave in.

Longwall retreating method is the preferred method because it has several advantages. The development galleries provide knowledge of geological disturbances, and the face operations can be adjusted accordingly. Maintenance of approach roads is easy, as they have solid coal on either side. Ventilation is good, roof support at the face is easier and chances of spontaneous heating in the goaf are less.

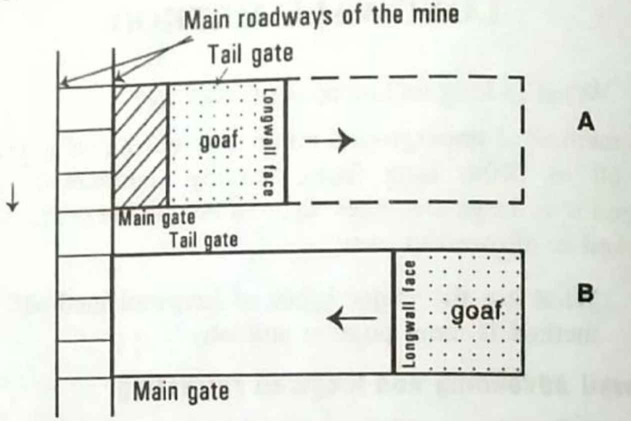


Fig : **A - Longwal Advancing, B - Longwall Retreating**

Q. 3. What is gate road, main gate, tail gate, stable?

Gate roadways : The approach roads from the main roadways of the mine to the longwall face are known as gate roadways. They are at right angles to the face.

Main gate : The gate roadway used for transport of coal is called main gate. It is provided with a belt conveyor. Generally it is an intake airway.

Tail gate : The gate roadway used for transport of supplies (materials) is called a tail gate. It has a track and a haulage. Generally it is a return airway.

Stable : In the longwall advancing system, the approach galleries of the face (i.e.gate roadways) are kept 8 to 10m ahead of the face to facilitate turning of the shearer to start its cut across the face. These advanced portions are known as stables.

Q. 4. How is the roof of a modern longwall face supported?

Longwall face support : Modern longwall faces are supported by self–advancing hydraulic powered supports (chocks, shields or chock-shields). Depending upon length of the longwall face, a number of powered supports (about 100), each of 400 to 850t capacity, are set side by side all along the length of the face. After the shearer cuts and advances 15-20m, the operation of shifting the powered supports is commenced one by one. The support is released from roof by lowering its legs, it is advanced forward and reset to the roof by raising the legs. It is then used to push the armoured face conveyor. Thus cutting by shearer, and shifting of supports and the face conveyor go on.

Support of gate roadways : In addition to the normal supports set during drivage of gate roadways, special supports are set from the face upto a distance of about 30m, These consist of I-section girders of 10cm × 10cm size erected at 1m interval resting on 40 tonne hydraulic props at both ends. Lagging is done by 1.2m long 10cm ×10cm wooden sleepers placed over the girder at 1m intervals.

Detailed investigations are done and calculations made to design the proper system of support at a modern longwall face. Approval is taken from the DGMS.

Q. 5. What is a stage loader.

Stage loader

It is about 20m long heavy duty auxiliary chain conveyor installed in the main gate to receive coal from the armoured face conveyor (AFC) and load it on to the gate belt conveyor. It stabilises the coal and prevents damage of the belt conveyor.

Q. 6. Describe briefly a double ended ranging drum shearer (DERD shearer) and its operation on a longwall face.

DERD

1. Double ended ranging drum shearer or DERD shearer is a cutter-loader used on longwall face. It is mounted on a skid plate provided with pads which rest on the armoured face conveyor (AFC) installed along the face. The machine has two ranging drums, one at either end, laced with cutting picks. Drums can be raised or lowered as required.
2. Shearer starts taking about 0.5m cut from one end of the longwall face, say from rise to dip, and moves along the AFC. While doing so, the leading drum is kept raised to

cut about top 70% of the seam thickness. The trailing drum takes bottom 30% section of the seam, down to the floor level, in the same travel.

3. A plough attached to the front end of the shearer deflects the cut coal on to the AFC.
4. After the shearer reaches the face end, it starts taking a fresh cut, moving from dip to rise. Position of drums is changed with the help of its ranging arm so that leading drum cuts top coal and trailing drum the bottom coal as before.
5. While cutting, water spray falls on cutter picks to suppress dust. Unless spray is on, the shearer cannot be put in operation.

Q. 7. State provisions of the regulations regarding powered supports.

Powered supports

1. Powered supports shall be advanced as soon as practicable after a web of coal has been taken off the face so as to ensure that area of unsupported newly exposed coal is kept to a minimum.
2. Powered supports shall be set securely and checked from time to time. When any defect is detected in any powered support, it shall be attended to as soon as possible and until then roof at that place shall be kept effectively supported with conventional supports.
3. Where, by reason of any irregularity in roof, floor or sides or due to any other reason, any powered support becomes ineffective, conventional supports in sufficient number shall be used.
4. Manager's support rules shall be followed.
5. Other rules :
   (a) Support controls shall be handled only by trained persons.
   (b) At a time only one person shall operate support valves. At a time only one support shall be moved.
   (c) All persons shall keep clear of a moving support and legs.

Q. 8. Draw layout of a powered support retreating longwall panel.

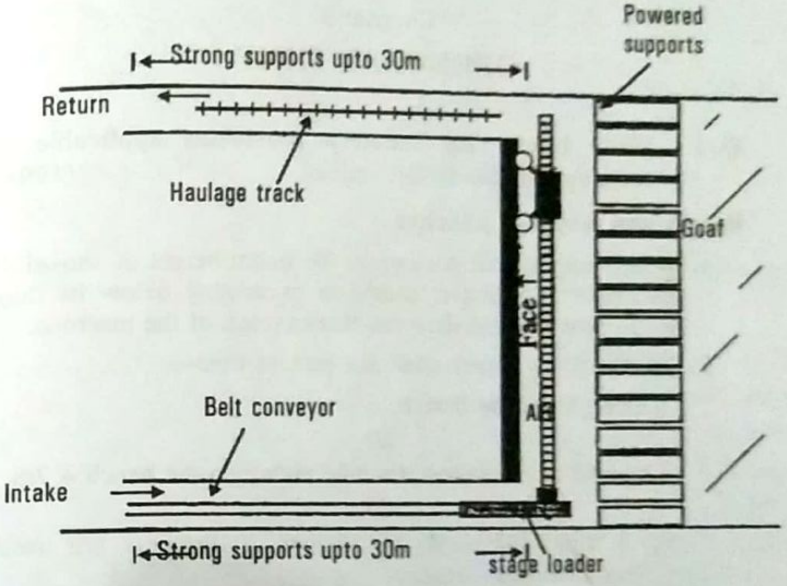


Fig : **Powered support retreating longwall face**

Chapter 9

OPENCAST MINE

Q. 1. Write briefly the statutory provisions applicable to forming benches in O/C mines. (1994)

Height and width of benches

1. Bench height shall not exceed the boom height of shovel. If excavator is used for loading or excavating below its floor level, bench height shall not exceed reach of the machine.
2. Width of any bench shall not be less than—
   (i) height of the bench,
   Or
   (ii) width of the widest machine plying on the bench + 2m
   Or
   (iii) 3 times the width of dumper, if dumpers are used, whichever is more.
   As a final operation of quarry the width may be reduced to not less than 3m.
3. Quarrying operations shall be conducted from top downwards. When persons are employed within 5m of the quarry face, adequate precautions shall be taken to ensure their safety by dressing the sides of benches. Special care shall be taken when any slip or other planes of weakness or other geological disturbances exist.
   In hard strata, sides shall be kept adequately benched or sloped to prevent danger of side fall.
4. No person shall be engaged or work or allowed to travel close to high sides/ benches, from which he may fall more than 1.8m vertically down, unless he is provided with and uses, a safety belt or rope.

Q. 2. What are the benefits of a good haulroad? What are its requirements?

Haulroad

Type of haulroad has a profound influence on operation of the mine. It is lifeline of an opencast mine.

Benefits of a good haulroad

- High production because of increased dumper speed.
- Better safety.
- Reduction in maintenance and less machine breakdowns.
- Saving in diesel, tyres, spares.
- Lesser operator fatigue, high morale.

Essential requirements

1. Width of haulroad should be not less than 3 times the width of largest dumper plus 5m.
2. As far as possible, haulroad should be straight.
3. Corners and bends, if any, should be so designed that operator can have a clear view of the road ahead for not less than 3 times the dumper braking distance (operating at 40kmph). Where this is not possible, separate roads should be provided for up and down traffic, each of width not less than 2 times the width of largest dumper plus 3m, with a divider and lights in between.
4. Gradient should not exceed 1 in 16. Gradients of ramps may be 1 in 10 but not more than 10m at a stretch, with permission from DGMS.
5. Portions of haulroad above the surrounding ground should be provided with strong parapet wall or embankment of the following minimum dimensions:

Top width	1m
Bottom width	2.5m
Height	equal to dumper tyre dia.

6. Where 35t or larger dumpers are used, a separate road should be provided for light vehicles of maintenance/ supervisory personnel. If it is adjacent to the haulroad, suitable fencing should be provided between the two.
7. Road surface and road bed should be designed on a scientific basis considering nature of ground, dumper size, climatic conditions etc.

8. Sufficient side drains and cross drains should be provided to keep the road bed dry at all times, including during heavy rains.
9. Road signs should be provided at strategic places.
10. No overhead line should cross the haulroad.
11. Haulroad should be kept well maintained, graded and free from loose material. It should be sprinkled with water frequently to suppress dust. In large mines, separate machinery and manpower should be allocated for maintenance of the haulroad.

Q. 3. Describe layout of an O/C mine, with a sketch, for producing one million tonnes of coal per year from a seam 9m thick with OB 22m. Assuming your own conditions, give a list of major equipment.

Layout of O/C mine

Conditions given :	seam thickness	9m
	OB	22m
	production	1 million tonnes per year
	method	opencast
Assumptions	: out of 22m OB, top 2m is soil	
	seam dip	1 in 20
	width of mining area	1km
	specific gravity of coal	1.3

Layout

1. Stripping ratio $= \dfrac{\text{OB thickness}}{\text{seam thickness x sp.gr of coal}}$

$$= \frac{22}{9 \times 1.3} = 1.88$$

i.e. 1.88m^3 OB will have to be removed per tonne of coal.

Annual coal production = 1 million tones

Therefore, annual OB = 1.88 million m^3

Soil is 2m in 22m OB

Soil = 1.88 x 2/22 = 0.17 million m^3

= 1.7 lakh m^3

Hard OB = 1.88 – 0.17 = 1.71 million m^3

2. Annual capacity of 4.6m^3 electric rope shovel (with 7 dumpers of 35t)

   = 0.5 million m^3 OB

   or 0.5 million tonnes coal

   Therefore, 4 shovels would be required for hard OB and 2 for coal.

   Capacity of 11 m^3 scraper = 0.85 lakh m^3/ year

   Hence, for soil 2 scrapers will be required, along with 1 dozer for pushing.
3. Boom height of 4.6 m^3 shovel is 10m. OB bench height can be kept 10m. For 4 shovels, 4 benches will be required.
4. Height of coal bench will be 9m.
5. Mine will be opened from outcrop side with a 45m wide box cut in the middle, with 2 wings (west wing and east wing) each 0.5km.
6. In each wing: there will be 1 coal bench of 9m and

   2 OB benches of 10m; bench width 60m.
7. **Drilling-blasting :** Deep hole blasting shall be done. OB shall be drilled by 260mm electric drills, 1 in each wing. Coal will be drilled by a 160mm dia diesel drill, 1 in each wing.

   Blasting will be by SMS or SME explosives.
8. **Loading :** Soil will be removed by scrapers and dumped outside the coal bearing area. It shall be later spread over the OB dump.

   Initially, hard OB will be dumped in external dump. When sufficient de-coaled area is created, OB will be dumped in internal OB dump.
9. **Haul road :** A 50m wide haul road shall be provided with a divider in the middle, and gradient shall be limited to 1 in 16. Adequate road signs shall be fixed. Sufficient drains shall be provided to deal with rain water.
10. **Dozer :** 6 dozers of 310kW will be required. At a time, 4 dozers will be in operation- 1 with scrapers and 3 with OB shovels.
11. Mine shall be worked for 3 shifts per day, 7 days a week. Dumpers, dozers, scrapers will be maintained and repaired in

the main workshop. Shovel and drill will be maintained in the field. A mobile workshop shall also be provided.

Main Equipment

electric rope shovels 4.6m^3	7
35t dumpers (6 per shovel)	42
scrapers (11m^3)	2
dozers	6
electric drills(260 mm)	2
diesel drills(160 mm)	2
Other equipment : motor grader (280hp)	2
road roller	1
water tanker (28,000 litre)	2
explosive van	1
mobile workshop	1
mobile canteen	1
cranes	2
tyre handler	1

Note : Coal production 1 million tonne per year =3400 tpd (300 day basis)

OMS (output per manshift) of such a mine may be 6t. Hence, manpower required = 3,400/ 6 = 570.

Q. 4. What are the factors on which stability of benches and sides of O/C mine depends? What measures should be adopted to prevent face and side fall accidents?

Or

Write a note on slope stability in O/C mine.

Stability of benches and sides

Stability of benches and sides depends on :

1. Height and width of benches, and side slope.
2. Physical properties of strata and presence of weak beds like black cotton soil and limestone beds.
3. Presence of cracks, slips, crushed zones, outcrop zones and faults.
4. Quantity of ground water and entry of external water.

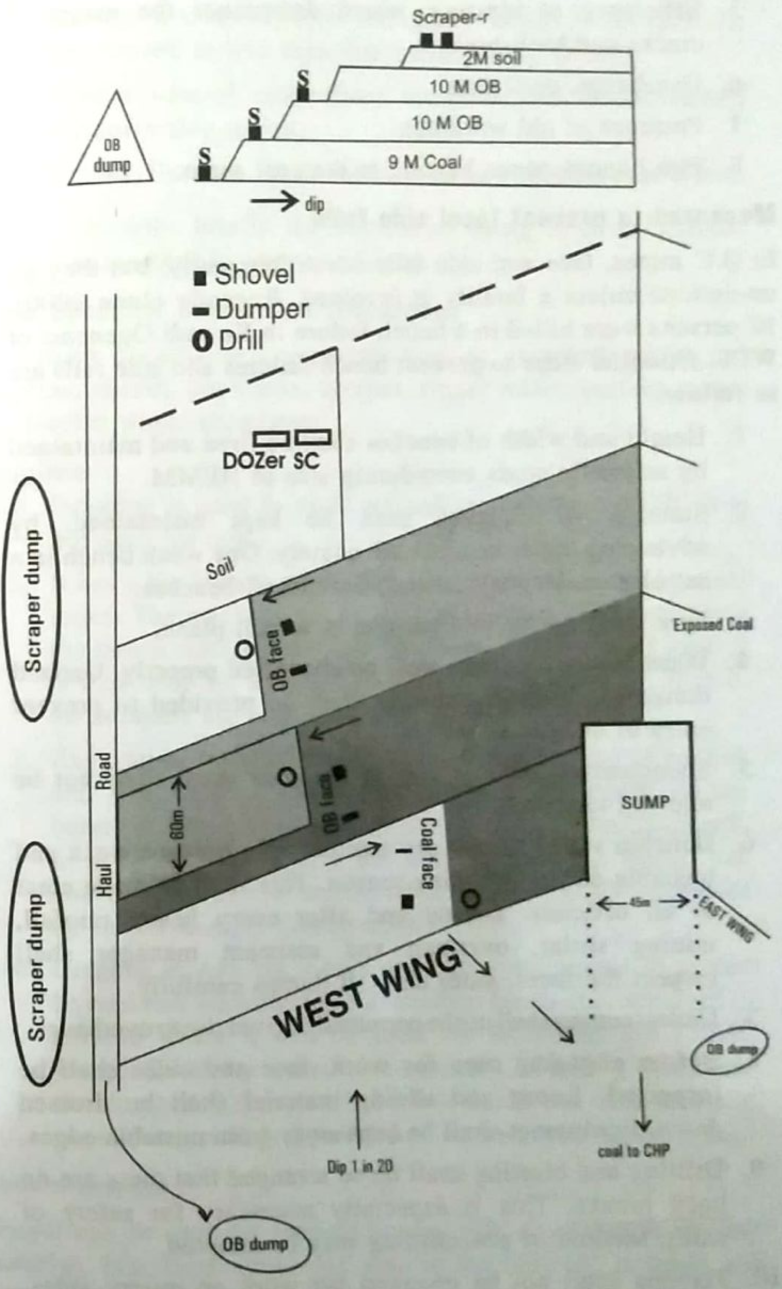

Scraper-r
2M soil
10 M OB
10 M OB
9 M Coal
S
S
S
OB dump
dip
■ Shovel
▬ Dumper
O Drill
DOZer SC
Scraper dump
Soil
OB face
OB face
Coal face
Exposed Coal
SUMP
Haul Road
60m
45m
EAST WING
WEST WING
Scraper dump
OB dump
OB dump
Dip 1 in 20
coal to CHP

Fig : Layout (Q. 3)

5. Efficiency of blasting, which determines the extent of cracks and back-breaks.
6. Overhangs, undercuts.
7. Presence of old workings.
8. Fire / spontaneous heating in the coal seam.

Measures to prevent face/ side falls

In O/C mines, face and side falls occur frequently, but they go un-noticed unless a fatality is involved. Recently (June 2000), 10 persons were killed in a bench failure in Kawadi Opencast of WCL. Essential steps to prevent bench failures and side falls are as follows:

1. Height and width of benches shall be fired and maintained by scientific study considering size of HEMM.
2. Stability of benches shall be kept maintained, by advancing upper benches adequately. One weak bench in a set of benches may cause failure of all benches.
3. Face shall not be laid parallel to a fault plane.
4. Water in working area shall be channeled properly. Garland drains of adequate capacity shall be provided to prevent entry of outside water.
5. Spontaneous heating/ fire in the coal seam shall not be allowed to spread.
6. Benches stable during dry weather may become weak and unstable during the rainy season. This shall be made clear to all officials. During and after every heavy rainfall, mining sirdar, overman and assistant manager shall inspect the faces, sides and OB dumps carefully.
7. Under-cutting shall not be permitted, it gives rise to overhangs.
8. Before engaging men for work, face and sides shall be inspected. Loose and sliding material shall be dressed down. Equipment shall be kept away from unstable edges.
9. Drilling and blasting shall be so arranged that there are no back breaks. This is especially necessary for safety of sides. Method of pre-splitting may be adopted.
10. Persons shall not be engaged for work on quarry sides, unless they are provided with safety belts.

11. During final operation of the quarry, bench width shall not be reduced to less than that permitted by DGMS.
12. Even in case of minor slides, the cause shall be ascertained for corrective action.
13. Cracks, fissures, weak zones shall be regularly monitored.

Q. 5 Describe briefly the method of using main excavation equipment in opencast mines.

Main opencast excavation techniques

The main excavation equipment used in opencast mines are dragline, shovel, payloader, scraper, ripper-dozer, surface miner and bucket wheel excavator.

Dragline

1. Dragline is used to excavate soil or soft/blasted OB. It is not used for coal.
2. It has a big bucket which hangs from a long boom by steel ropes. The machine sits on the bench to be excavated, cuts the bench material and dumps it into the de-coaled area. It is thus used for excavation and also for dumping. Hence, no dumpers are required.
3. Excavation capacity of dragline depends on size of bucket, and thickness of OB bench depends on length of the boom. A 96m boom dragline can cut about 40m OB bench. In a multi-seam mine, it sits over the last OB bench, just above the lowest coal seam—other OB benches are excavated by shovel-dumper combination.
4. Dragline is very big, heavy and costly equipment. It cannot be marched from one mine to another. Hence it is deployed in a mine where it can be used for its entire life (30-40 years). Seam dip should not exceed 1 in 8 (7^0), otherwise the dumped OB may roll back towards the coal face and require re-handling. Seam should be free from faults, dykes.

Shovel-dumper

Shovel can be used for loading coal or OB. It can excavate soft material, but, hard strata/coal has to be blasted. It loads the material into dumpers which transport it to OB/coal dump.

Shovel-dumper combination can be used in any mine condition and it is the most widely used method of loading in opencast mine. There is hardly any opencast mine where shovel-dumpers are not used.

Payloader-dumper

Payloader is a wheel mounted loading machine used for loading blasted coal into dumpers. It cannot be used for OB because it is not as rugged as shovel. Payloaders are very commonly used for loading small dumpers/tipping trucks.

Shovel- conveyor

Transport of OB or coal by dumpers is a costly operation. If volume and distance to be covered cross a certain limit, crusher-conveyor system is used. Coal excavated is dumped by dumper into nearby feeder-breaker in the quarry. From feeder-breaker coal is transported by belt conveyor to coal bunker on surface. Feeder-breaker is shifted from place to place and belt conveyor is extended.

In some mines OB is also similarly dumped by dumpers into mobile crusher installed in the quarry. Crushed OB is transported by belt conveyor to OB dump where it is spread by spreader conveyor. In one mine in India, both coal and OB are handled by crusher-conveyor combination. In another mine, where the seam is steeply dipping, coal is dumped by shovel directly into a mobile crusher and crushed coal is conveyed by a belt conveyor to surface bunker.

Scraper-dozer

Scrapers are used for excavating only soil. For easy loading, it is pushed by a dozer. Scraper transports the loaded material 300-400m distance and unloads it into OB dump spreading it over a distance. This soft soil is used for reclamation. Scrapers are practically not in use at present in opencast coal mines in our country.

Ripper-dozer

Ripper-dozer is a dozer which has a plough like attachment behind it for ripping hard OB/coal. It is used where material is hard for the scraper, or where thick OB band in a coal seam or thin stone parting between two seams is to be separately excavated. Ripper rips the material over an area, which is then pushed aside by dozer for loading by payloader into tippers/dumpers. Ripper-dozer is useful for excavating OB/coal near populated areas, but, these days surface miners are utilised for this purpose.

Surface miner

This machine is meant for coal production and not for OB removal. It has been introduced in Indian opencast coal mines recently. It works in the same manner as a continuous miner works underground. The machine cuts coal in thin layers (0.2-0.6m) and loads it into dumpers by it boom conveyor. Alternatively, the cut coal is dumped by the conveyor on the ground, and later loaded by payloader into tippers/dumpers for transport to siding/coal dump.

Coal cut by surface miner is small in size, upto 100mm. Hence, no crushing is required. Surface miner is also used for mining stone band of a thick seam separately to improve the quality of coal. Surface miner does not need blasting. Hence, it is quite useful for excavation near populated areas, especially where the OB is also soft. Surface miners are becoming increasingly popular in Indian coal mines.

Bucket wheel excavator

It is the main excavating equipment of lignite mines. Buckets of BWE are fitted on periphery of a rotating wheel. As the wheel rotates, buckets excavate lignite/soft OB and dump it into its central conveyor. Excavated material is loaded into a belt conveyor through a bridge conveyor and transported to respective dump. Where OB is somewhat hard, it is to be blasted before it can be excavated by BWE.

Q. 6. What are the rules regarding safety of OB dumps?

Safety of OB dumps

1. Dump shall be formed on stable ground—if floor is slippery, it shall be roughed up by blasting or ripping to a depth of 1-1.5m. Soft material like soil shall not be dumped at the floor.
2. Slope of OB dump shall be determined by natural angle of repose of material being deposited, but it shall not exceed 37.5° from the horizontal.
3. Dump face shall not be retained by artificial means at an angle in excess of its natural angle of repose.

4. Dump height should be designed on scientific basis. If dump height is more than 30m, it shall be benched and the bench height shall not exceed 30m.
5. Toe of the dump shall not be permitted to approach railway or road, public works or building, closer than a distance equal to height of the dump.
6. A fence shall be erected around the advancing toe of the dump at a distance not less than height of the dump to prevent persons approaching the dump.
7. Water shall not be allowed to accumulate in or around the OB dump.
8. Dumps shall be inspected in every shift. Special care shall be taken during and after heavy rains.
9. Dump shall not be formed directly below and near an over-head line.

Precautions during dumping

1. Dumping area shall be provided with a berm of height 1m or half the dumper wheel dia.
2. Non- dumping area or unstable area shall be demarcated by dumping material to a height of 2m.
3. Dumping shall be stopped if there are crack/signs of instability.

Q. 7 What precautions will be taken in :
Making an overburden dump in a big opencast mine using draglines. (2009)

Precautions in making OB dump in a dragline mine

1. Height and slope of dump face should be designed by a research institute based on type of OB, seam dip, nature of floor, drainage, reach and dumping height of dragline, production etc.
2. Interface layer i.e. debris or coal dust, fragmented rock, soil mixed with water should be cleared as far as possible from the de-coaled floor before dumping by dragline starts. If it cannot be avoided, the floor should be ripped or blasted to a depth of 1-1.5m before start of dumping by dragline to improve frictional resistance at base of the dump.

3. Top soil should be dumped separately. Under no circumstances should such material be placed at base of the dump.
4. OB excavated from shovel-dumper benches should not be dumped on or near the freshly created dragline dump to avoid further loading of partially consolidated dragline dump. Ideally, it should be dumped atleast two cuts away.
5. Valleys in dragline dump should be levelled to avoid rain water ponding between heaps of dragline dump.
6. If coal rib is left at floor level, the rib should be punctured at every 100-150m to prevent accumulation of water behind it.
7. Annual production target should be so fixed as to provide adequate dumping space with safe dump height and slope.
8. Dump height and slope should be monitored regularly by trained personnel using sophisticated survey instruments.
9. Trained competent persons should be deployed for frequent inspection of the sump. If there are any cracks or other signs of deterioration of stability, he should inform the manager forthwith.
10. Manager should frame and implement 'dumping rules' incorporating all the above points.

Q. 8. What are the duties of truck/ dumper operators?

Duties of truck /dumper operators

1. Before commencing work, truck driver or dumper operator shall check the vehicle-especially brake, parking brake, emergency brake, steering, horn, audio-visual alarm, tyre pressure. If he finds any defect which is likely to make driving unsafe, he shall report the matter to the competent person and shall not operate it until the defect has been rectified. He shall write report of his inspection.
2. Windshield shall be kept clean.
3. (a) Before moving the dumper, he shall blow horn.
   (b) He shall not drive the vehicle at an excessive speed, keep it under control at all times, and pay attention to road signs.
   (c) He shall negotiate downhill gradients in low gear so that minimum braking is required.

(d) He shall keep sufficient distance from the vehicle ahead, particularly from a vehicle with twin rear wheels from which a stone piece, wedged between the tyres, may fly back into wind screen of his vehicle.

(e) He shall not attempt to overtake another vehicle unless he can see clearly far ahead to be sure he can pass it safely. He shall blow horn before overtaking.

(f) When approaching a loading machine he shall sound the horn, and shall not attempt to go near or pass it until he has received a proper audible signal in reply.

(g) Before crossing a road or railway line, he shall reduce his speed, look in both directions along the road or line, and shall cross it if it is safe to do so.

(h) He shall not operate the truck or dumper in reverse unless he has a clear view of area behind the vehicle, or he has the assistance of a 'spotter' or 'pitman', duly authorised in writing by the manager. He shall give an audible warning signal, before reversing the vehicle.

(i) Driver shall sound an audible warning signal while approaching a blind corner, or any other point from where persons may walk in front unexpectedly.

4. He shall not come out or put his head out of a dumper while it is being loaded.
5. He shall see that-
   - the vehicle is not overloaded
   - material does not project horizontally beyond the sides of body, and
   - material projecting beyond the front or rear, is indicated by red flag during the day and by a red light after daylight hours.
6. While unloading material in the dump, he shall take care that his vehicle may not roll down from the dump. After unloading, he shall not move the vehicle, before the body has come down to its normal position.
7. Driver shall not park the vehicle where there may be a danger. He shall avoid parking on a gradient.He shall park the vehicle -
   - in *reverse gear*, on level roads and down gradients, and
   - in *low gear* on up gradients
8. He shall not allow any unauthorised person or more than authorised number of persons to ride in the vehicle. Nobody shall be allowed to sit outside the cabin of a moving vehicle.

Q. 9. What is audio-visual alarm?

Audio-visual alarm

When a truck or dumper backs up, a person standing behind the vehicle may get crushed. To alert such a person, trucks/ dumpers are provided with audio-visual alarms. As soon as the vehicle is put in reverse gear, a special horn starts blowing and the backlight flashes. It is a statutory requirement that truck, dumper or loader shall not be run unless the audio-visual alarm is working.

Q. 10. Discuss briefly precautions to be taken in respect of shovel trailing cable in opencast mine.

Care of shovel trailing cable

1. Field switch of the shovel should be on shovel bench itself so that when required, power can be cut off from field switch quickly.
2. Field switch should be so positioned that trailing cable does not need to cross the haul road. When crossing is unavoidable, suitable cable bridge should be made. Cable should not be buried under haul road.
3. There should be no temporary joint in trailing cable.
4. Cable should always be loose so that it is not pulled by the machine.
5. Cable should not be handled by shovel bucket or dozer. If the shovel has a cable reel, it should always be maintained in working condition.
6. Cable should be kept in a safe position to avoid damage by boulders falling from the face, or damage by dumper or dozer. It should not be lying in water or muck.
7. Before marching the shovel back, the operator should ensure that cable has been removed by cable man to a safe distance.

8. Cable man should use safety gloves while handling live cable.
9. At end of the shift, power to the machine should be cut off from field switch.

Q. 11 What precautions should be taken by shovel cable man?

Precautions by shovel cable man

1. At beginning of the shift, shovel cable man should inspect the cable. In case of damage, he should immediately inform shovel operator and competent person.
2. While handling cable he shall use safety hand gloves.
3. He should pay attention to signals given by shovel operator. When shovel is to be marched ahead, he should keep the cable loose so that it is not pulled by the machine. During backward movement of the shovel, he should shift the cable to avoid it being crushed.
4. Cable should be kept away from water/muck and in a safe position to prevent damage by shovel, dumper, dozer or falling boulders.
5. He should not allow kink in cable, and keep it coiled in shape of figure 8. He should not sit on the cable.
6. He should remain at a safe distance from the shovel in operation and from the face/sides.
7. He should wear shoes, helmet and reflective jacket.
8. He should not sleep while on duty.

Q. 12. To what points shall the operator pay attention during shovel operation?

Precautions by shovel operator

1. Check the machine. Examine the face, there should be no over-hang.
2. Before marching, ensure availability of adequate loose cable.
3. While marching the shovel backwards, swing the cab and observe position of cable and cable man.
4. Do not keep the bucket hanging.
5. Avoid intermittent/jerky swinging.
6. Do not swing before bucket is clear of the face.

7. Ensure no machine or persons are around the machine during operation.
8. Before leaving the cab, place the bucket on the ground and cut off the power.
9. Do not try to clean bench floor by bucket; get it dozed.
10. Do not march the machine forwards or backwards, without giving a warning signal and without getting signal from the cable man.
11. Load the dumper evenly and do not overload.
12. Leave too large boulders in the face.
13. While swinging loaded bucket, take care that boulders do not fall on dumper bonnet or the operator cabin.
14. Do not allow any unauthorised person in machine house or cab.
15. Operate the machine on level ground only.
16. Do not take too deep a cut, and retract the bucket as soon as it is full.
17. Unload the bucket from a minimum height which permits unobstructed opening of bucket door.
18. In course of travel, guide the bucket in direction of travel so as not to obstruct proper view of the road. Bucket should be held at a height of 1 to 1.5m from the ground.
19. Station the shovel on a sound ground and at a safe distance when blasting operations are on the way.

Q. 13. Describe precautions to be taken in drilling blast holes in opencast mine.

Precautions during drilling blast holes

1. The block to be drilled shall be dozed to remove loose material & boulders. Hole positions shall be marked by blasting overman using measuring tape and depth of each hole shall also be marked. Holes shall not be placed in cracked zone.
2. At shift beginning, drill operator shall check the machine – controls, crown block, hydraulic system, brake, lights,

emergency trip, availability of fire extinguisher, hoses not leaking etc.

3. Machine shall not be taken closer than 3 m from bench edge. It shall be at right angles to the edge.
4. Drill shall be levelled and jacks tightened before commencing to drill.
5. Holes shall be drilled at the marked places and to correct depth.
6. Drilling shall always be in retreating fashion i.e. towards the supply switch. While retreating, cable shall be wound on cable reel.If there is no cable reel, it shall be picked up and placed on cable hanger. Cable shall not be dragged over drilled holes.
7. Trailing cable shall not be unfolded from the cable reel fully – at least one loop shall be left in the reel.
8. As holes are drilled, their mouths shall be plugged or covered to prevent drill cuttings falling into the hole.
9. For marching exceeding 100 m, or for travel downhill or crossing overhead line, the mast shall be lowered. Before lowering or raising the mast, it shall be ensured that there is nobody in the vicinity.
10. While drill is working, operator shall not leave the control lever.
11. After drilling and before blasting, drill shall be parked at a safe place.
12. Drill shall be operated only by authorised operator.

Q. 14. What safety precautions should be taken by dozer operator?

Precautions by dozer operator

1. **Checks at shift beginning**

- Operator shall check the dozer and make sure that it is in efficient working order. He shall check specially brakes, warning devices, audio visual alarm, light, horn, seat belt and fire extinguisher/fire suppression system. There should be no oil leakage, cab window should be clean.

2. **Precautions in running**

- Before moving the dozer, he shall see that no body is present in the vicinity.

- He shall handle the dozer carefully, keep it under control at all times and negotiate downhill gradient in low gear so that minimum of braking is required.
- Dozer shall not be worked on a gradient exceeding 1 in 3.
- The operator shall not drive too fast, shall avoid distraction, drive defensively, and shall not attempt to overtake another vehicle unless he can see clearly far enough ahead to be sure that he can pass it safely, and shall give audible signal before overtaking.
- While marching from one place to another, dozer shall not be run in reverse position – it may crush a person behind.

3. **Precautions in dozing**

- Before taking dozer near a shovel, he shall obtain signal from shovel operator. Dozing shall be done only after stopping the shovel and dumpers.
- He shall not take dozer too near the quarry face or side or base of dump - fall of material may cause accident.
- For dozing near edge of quarry bench, he shall keep dozer at right angle to it to prevent danger of dozer toppling.
- Dozer shall not be moved across the slope - track may slip or dozer may topple.

4. **Precautions in dumping**

- A berm shall always be left at the dump edge.
- Dump edges shall be inspected frequently for cracks or loose muck.
- When dumping is in progress, operator shall keep the dozer at a safe distance from the place where dumper is dumping.
- Dozer shall not be used for dozing material at base of OB dump, as OB may slide and engulf the dozer and the operator.(Ref. Accident in Jayant Opencast Dec. 2008)

5. **Parking**

- Dozer shall be parked on hard level ground, not near highwall or valley edge, at a safe place which does not obstruct movement of other machinery.
- Dozer shall not be left on slope unless it is so required,

and while doing so, it shall be facing downwards – with the dozer blade and ripper shanks firmly placed on the ground.

- Before leaving the machine, operator shall rest the blade on the ground and stop the engine.

6. **General**

- No unauthorised person shall be allowed to ride on the dozer.
- No body shall stand on dozer bade or dozer arm while engine is running.
- Before any repair/adjustment is carried out, blade shall be lowered to the ground and engine stopped.
- Operator shall wear seat belt and put on ear muffs.

Q. 15. What precautions will you take during supervision of loading and transport of over burden by an excavator and 3 tippers/dumpers? (2014)

Supervision of shovel-dumper working

- Face height shall not exceed shovel boom height. If it is more, dozer shall be engaged to reduce height and prevent overhang.
- Face and sides shall be kept well dressed. Special attention shall be paid after heavy downpour.
- Dumpers shall not crowd in shovel working area. Dumper shall be placed for loading only after getting signal from shovel operator.
- Bench shall be cleared of fallen/scattered OB by dozing at shift beginning and from time to time. During dozing, shovel loading shall be stopped..
- Dumpers shall not be overloaded. Load shall be central. Too large boulders shall not be loaded.
- Shovel operator shall withdraw bucket from the face as soon as it is full.
- During loading, dumper operator shall not leave or enter the dumper, nor stick his neck out of the window.
- Shovel/dumper shall blow horn before commencing movement.

- Cable man shall provide loose cable for shovel marching, keep cable away during its reverse marching, keep slack cable in a position to prevent damage by falling stones and moving equipment. He shall be at a safe distance from shovel.
- Haul road shall be kept graded and water sprayed.
- Dumper operators shall follow traffic rules.
- At shift beginning and especially after a spell of heavy downpour, OB dump shall be inspected to check presence of any cracks/signs of instability, maintenance of safety berm at the edge. OB shall be dozed from time to time to provide space for safe dumping. Lighting shall be adequate.
- Bench width shall not be reduced as would cause instability of benches.
- Working area shall be adequately illuminated
- At shift end, shovel shall be parked on stable ground away from the face and sides.
- No unauthorised person shall be allowed to operate any equipment.
- No light vehicle shall be allowed to enter shovel working area
- All persons shall wear safety helmets and reflective jackets.

Q. 16. Describe safety precautions to be taken by dragline operator.

Safety precautions by dragline operator

1. Before commencing operation, check that nobody is inside the dragline for maintenance work and no part is left open.
2. Inspect the machine all around to check condition of boom rope, hoist rope, drag rope, dump chain, trailing cable, railing and ladder.
3. Check all brakes, safety systems & safety devices. Walking shoe should be in proper position.
4. No person, vehicle or equipment should be present in swing range of the dragline.
5. Tub should be properly placed on the ground and it should be stable.

6. Machine room should be free of oil grease etc.
7. Do not use the machine to lift large boulders that could cause boom or bucket rope to snap.
8. Do not drag the bucket longer than necessary, lift it as soon as it is filled.
9. Dress the highwall with bucket.
10. Do not swing with a jerk, do not stop swinging with a jerk.
11. While dumping, do not lift the bucket higher than necessary.
12. Do not run the machine if compressor relief valve is continuously blowing.
13. Stop the machine if there is unusual sound from any part.
14. Do not site dragline at a distance less than 20 m from crest of bench.
15. Before swinging dragline, be sure that there is adequate clearance all around the machine and superstructure including ropes and bucket.
16. Before marching the dragline from one place to another, inspect the route. Passage should be at least 40 m wide, gradient not exceeding 1 in 8(7°), free of obstruction.
17. Before leaving the seat, place bucket on the ground and cut off power.

Q. 17. What are the hazards in extracting pillars by opencast method? Describe precautions taken against the same. (2002, 2009)

Hazards of pillar extraction by opencast

1. Parting over developed pillars may collapse, and men & equipment may fall into the galleries.
2. Spontaneous heating in old workings may aggravate due to formation of cracks by blasting. Smouldering heating may turn into active fire on exposure to air.
3. Blasting in opencast workings may cause roof/side falls in connected u.g. workings due to vibrations.
4. A blown-out shot may cause fire or explosion of coal dust in u.g. workings.

5. Equipment working in hot strata may catch fire. Men may suffer health hazards.

Precautions

1. Surveying the approachable underground workings. Marking position of galleries/junctions on the plan and later on the ground as workings advance.
2. Cleaning the u.g. workings of coal dust and doing heavy stonedusting.
3. Isolating u.g. workings by a ring of isolation stoppings.
4. Withdrawing men from nearby u.g. workings before blasting and permitting re-entry only after thorough inspection, dressing, support and check for CO.
5. While drilling OB, leaving a parting of 3m over the roof of u.g. gallery. Putting pilot hole for checking the parting before regular drilling of blast holes.
6. Filling bottom 0.6m of blast holes with wet sand, and filling the bottom 2m by sand if there are cracks in the blast hole.
7. Extracting coal and the first OB bench over the seam by backhoe standing on OB.
8. Good cleaning and maintenance of backhoe, drill, dozer to cut down chances of catching fire.
9. Check for CO at the face every two hours.
10. Cooling the coal being extracted by jets of water.
11. Taking due precautions in blasting in hot strata.
12. Blasting only a limited quantity of coal at a time and lifting the same fast to prevent it from catching fire.
13. Not using delay detonators in blasting.
14. Constant competent supervision.
15. Good arrangements for fire fighting.
16. Permission from DGMS before starting extraction.

Q.18 a. What are the benefits of using surface miners?
b. Enumerate safety features of surface miners.
c. Write a Code of Practice for use of surface miners.

Surface miner : benefits

1. It eliminates drilling/blasting. Hence,

  - Accident risk is reduced.
  - Coal near village/hutments/surface structures etc. can be extracted which otherwise would remain locked up.
  - There is saving in manpower and cost.
  - It provides stable quarry sides.
  - There are no blasting cracks; hence, chances of spontaneous heating in coal seam get reduced.
2. Thin seam extraction is possible.
3. Quality of coal can be improved by mining stone band of the seam separately.
4. Crushing cost is saved, because it produces coal of small size. Truck payload improves due to uniform size of coal which means reduction in transport cost.
5. It is environment friendly because there is freedom from problems of ground vibration and fly rock.
6. Supervision is easy.
7. Tyre wear/tyre cost reduces because surface miner leaves a smooth bench floor.

Safety features

1. Brake, horn, light, pre-start warning
2. Emergency stop
3. Water sprinkling system
4. Fire extinguisher—approved type
5. Safety guards/cover plates.

Code of Practice for surface miner

1. Surface miner shall be operated only by trained, authorised operator.
2. Operator shall not permit any other person to ride on the machine.
3. At shift beginning, he shall start the machine only after safety checks by competent person. There should be adequate water in tank for dust suppression.
4. Before operating, he shall himself also check the machine, give warning signal, and see that persons nearby have moved to a safe distance.
5. He shall keep the cabin glass, ladder and walkway clear of coal, stone, grease, oil.

6. He shall not excavate unless the dust suppression system is working satisfactorily.
7. Cutting work will be started only after ensuring full set of sharp cutting picks to limit ground vibrations.
8. He shall not swing the conveyor discharge head over any person/power cable.
9. While machine is in operation, he shall see that his assistant remains at a safe distance and in a position where he can give signal to stop the machine in emergency.
10. At shift end, operator shall unload all coal from the belt conveyor, lower the boom to the ground, stop the machine, and leave controls in 'neutral'. He shall handover cabin keys to competent person.
11. Truck drivers shall be duly trained. They shall not take the vehicle dangerously close to the machine.
12. Surface miner operator and the supervisor shall write a shift report.
13. Manager shall formulate and implement a safety COP for maintenance, supervision and operation of surface miner.
10. Operator shall not operate the machine on steep gradient, shall not change speed or direction suddenly otherwise machine may become unstable.
11. No other machine shall run nearby.
12. Lining of operator cabin shall be kept secure to limit noise level to 90 dB(A).

Q. 19. Write a short note on :
Highwall mining.

Highwall Mining

Highwall mining is a method of extracting coal from highwall of an opencast mine by driving galleries in the coal seam using remotely operated highwall miner.

The method is used when opencast mine reaches a limit beyond which coal extraction is not possible due to economic reasons or due to local surface constraints (populated area or surface structures).

Method

- Base unit of HW miner (length 17 m, width 10 m, height 8 m) is set on the bench in front of the highwall. Its remotely operated cutter head, similar to the cutter head of continuous miner used underground, cuts a gallery(entry) in coal. As coal is cut, a push beam keeps it pushing in. When one push beam reaches its length, another one is automatically added to it. Gathering arms of the cutter head direct the cut coal into an auger conveyor which transports coal to a chain conveyor outside the gallery. Coal then falls in a short belt conveyor for dumping it behind or to one side of the base unit for further transport by payloader/trucks.

- After the gallery has progressed about 250 m, the cutter head is pushed out as pusher beams are cut out one by one.
- Base unit is then shifted and placed to cut a parallel gallery some distance away in a similar fashion. Thus a series of galleries are cut.
- Size of web pillar between adjacent galleries is so designed that roof of entries does not collapse.
- The entries do not need any support or ventilation.
- All controls are computerised with option for manual control. No person is required to enter the gallery for any purpose.
- Size of cutter head is chosen according to seam thickness.
- In a seam 1.5 m thick, HW miner can produce about 40,000 t of coal per month.
- HW miner is of modular construction for easy dismantling, transport and refitting in another mine.

Safety requirements

1. **Protective canopy** in front of HW miner to protect against boulders falling from highwall.
2. **Methane sensor** mounted on the cutter head to cut off power when CH_4% exceeds set value (0.7%)
3. **Gamma detector** to adjust cutter head position on variation in seam thickness to prevent it cutting roof or floor stone.
4. **Navigator** to detect deviation in direction of entry so that next entry is suitably located to ensure minimum web width.

Benefits

1. Coal can be extracted beyond economic limit of usual opencast method.

2. It is possible to extract coal which would otherwise remain un-extracted due to surface constraints (hill, forest land, river, road, village, OB dump or surface structure).
3. OMS is high. The system needs only 6-7 persons per shift.
4. No initial development is needed. Cost of production is low.
5. Method is as safe as opencast method. No one is required to enter the galleries. Moving auger conveyor produces some ventilation. Gas detector mounted on the cutter head monitors CH_4% and cuts off power when it exceeds the pre-set value.

Limitations

Seam should be free from geological disturbances, roof & floor should be hard, seam dip not exceeding 1 in 10 and make of water should not be high.

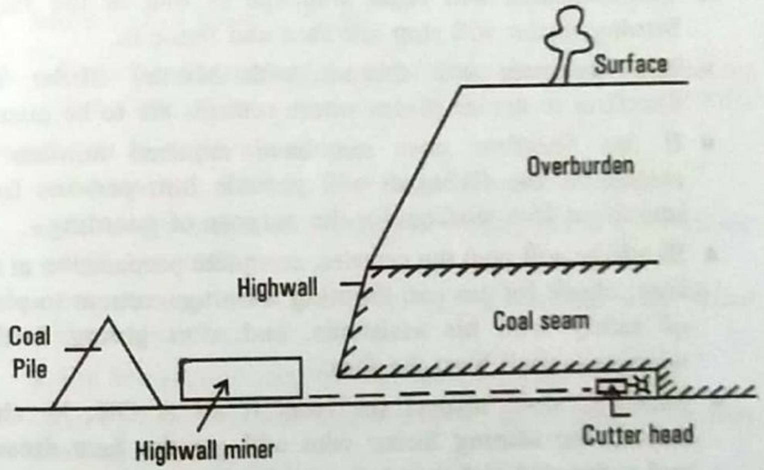


Fig : **Schematic diagram of highwall mining**

Introduction in India

Highwall mining has been used in USA and Australia for decades. In India, it is presently used in Medapalli Opencast (Ramagundam, SCCL) and Sharda Opencast (WCL). The method is likely to be used in several other mines.

In Sharda Opencast, highwalls have been created by cutting a series of trenches(February 2011) in the mine property.

Chapter 10

SHOTFIRING

Q. 1. Two galleries are approaching each other. What steps will be taken? (2014)

Steps to be taken when 2 galleries are about to join :

- Overman shall inform Mining Sirdar and Shotfirer. when two faces reach within 10m of each other.
- The Overman will order stoppage of one of the faces. Mining Sirdar will stop one face and fence it.
- The Overman will discuss with Mining Sirdar and Shotfirer to decide places where sentries are to be posted.
- If the Shotfirer does not have required number of assistants, the Overman will provide him persons from identified face workers for the purpose of guarding.
- Shotfirer will post the sentries, complete preparation at the face, check for gas and shouting warnings, retreat to place of safety with his assistants, and after giving further warnings, shall blast the face.
- Shotfirer shall inspect the face. If all is OK, he shall inform the Mining Sirdar who will get the face dressed and supported and then intimate the Shotfirer.
- Shotfirer will withdraw the sentries and permit men to enter for work.

This process will be repeated until the two galleries join.

Q. 2 What steps will an overman take on detecting inflammable gas during drilling in a working face? (2008)

Actions by overman on detecting CH_4 at the face during drilling

1. Stop drilling work.
2. Arrange to cut off electric supply of the district.
3. Stop charging, stemming, blasting in the district on return side of the face.

4. Arrange to extend air coursing/air pipe to dilute and remove CH_4 from the face.
5. Allow normal work to resume only after making sure that CH_4 has been removed and conditions are safe.
6. Inform the manager. Write a report of occurrence and actions taken.

Q. 3. What are the dangers of solid blasting?

Dangers of solid blasting

1. Danger of blown-out shot which can cause an explosion of fire damp and coal dust.
2. Increased chances of cut-off and misfires.
3. More vibrations—adverse effect on roof/sides/supports.
4. More CO in blasting fumes.

Q. 4. Describe the precautions to be taken during solid blasting in a gassy mine. (1988)

Precautions in solid blasting

1. Solid blasting shall be done only by a person who—
    - holds a manager or overman or mining sirdar's certificate with gas testing
    - has received practical training in blasting with delay detonators, and
    - has been authorised by manager for solid blasting
2. Only P5 explosive and 'non-incendive' short delay detonators shall be used.
3. The pattern of shot holes, amount of charge in each hole etc. shall be laid down by the manager. In devising the pattern—
    - delay interval between the first and the last shots of the round shall not exceed 150ms (millisecond)
    - delay between 2 consecutive shots shall not exceed 60ms
    - distance between any 2 adjacent shot holes of different delays shall be not less than 60cm
    - explosive in any hole shall not exceed 1000g in deg.1 seam and 565g in deg.2 seam
4. In deg.2 seam atleast 284m^3 per min air shall reach within 4.5m of the face. In deg.1 seam atleast this quantity shall flow in the last ventilation connection.

5. Precautions for blasting permitted explosive shall be observed, namely—
   - Check for presence of breaks in the hole; hole shall not be blasted if there is a break in the hole.
   - Check for gas at mouth of the hole and within a radius of 20m of the place of firing with an approved methanometer by assistant manager/ overman before charging the explosive, and before blasting. No shot shall be fired if 0.1% or more inflammable gas is found in the said zone in deg.1 mine, or 0.5% or more gas is found in deg.2 seam.

6.(a) Blasting shall be done by inverse initiation.

(b) Number of holes in a round shall not exceed 25.

(c) Holes shall be connected 'in series' and the circuit shall be checked by an approved circuit tester.

(d) Only approved type exploder well maintained and approved cable shall be used.

(e) Connections between shotfiring cable and the detonator leads, as well as between the consecutive leading wires shall be adequately insulated.

(f) Roof, floor and sides of all workings within 90m of place of firing shall be thoroughly drenched with water, so that dust is always combined with atleast 30% of weight with water in intimate mixture.

7. No solid blasting shall be done within 60m of any geological disturbance.

Wedge cut

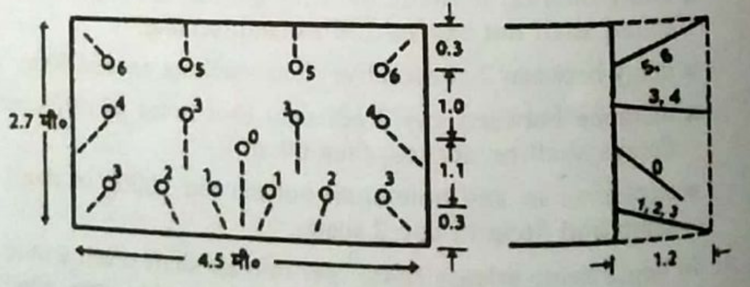


Fig : **Wedge cut pattern**

Face : 4.5m x 2.7m

Explosive : Lowest row 550g/hole
Other holes 500g/hole
Total about 8kg

Coal : 20t
Detonator factor : 1.3t/detonator
Powder factor : 2.5t/kg

No. of holes = area of face/0.8 = (4.5 x 2.7)/0.8 = 15
Coal = width x height x advance x sp.gr
= 4.5 x 2.7 x 1.2 x 1.4 = 20t

Face Advance per blast : 1.2m

Note : DGMS does not normally permit solid blasting in deg.3 seam. In very special conditions, permission is granted with certain stipulations, knowledge of which is not necessary for the overman.

Wedge cut for solid blasting has already been shown above. Fan cut is shown in the sketch below.

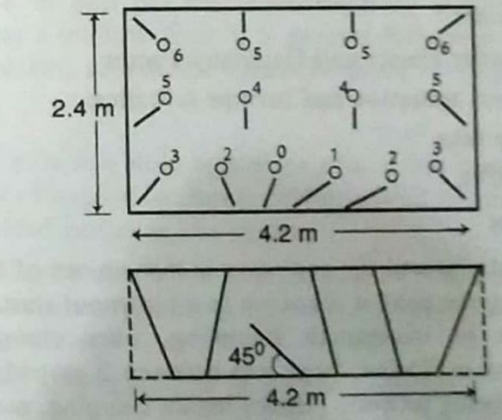


Fig : **Fan cut pattern**

Q. 5. How will you deal with a mis-fire?

Dealing with a mis-fire.

1. All entrances to the place shall be fenced.
2. Shotfirer shall make an attempt to fire the shot after correcting any defect in the cable or connections.
3. If the mis-fired shot does not explode, it shall be dislodged by blasting a reliving hole atleast 0.3m away from the mis-fired hole. The hole shall be drilled in presence of the shotfirer.

Powder Factor = 15/6.4 = 2.34 tonnes per kg

Detonator Factor = 15/14 = 1.07tonnes per detonator

These factors depend on hardness of coal, dimensions of gallery, cleavage in coal, type of explosive etc., and more importantly on effectiveness of drilling and blasting. These factors are indicative of efficiency of drilling and blasting operations.

Some examples :

	Powder Factor (P.F.)	Detonator Factor (D.F.)
Solid blasting	2 – 2.5 t/kg	1.1 –1.3
Depillaring	4.5 – 5 t/kg	1.4 –1.5
Cut blasting	5 – 8 t/kg	1.8 – 2.
Opencast		
Coal	7 – 10 t/kg	
OB	1.8 – 2.5 m^3/kg	

Direct initiation and inverse initiation

The placing of detonator in the last cartridge to be inserted in shot hole with the active end of detonator pointing inwards is known as **direct initiation**. This position tends to minimise risk of gas ignition, and it is used where coal cutting machines are used or blasting is done in slices.

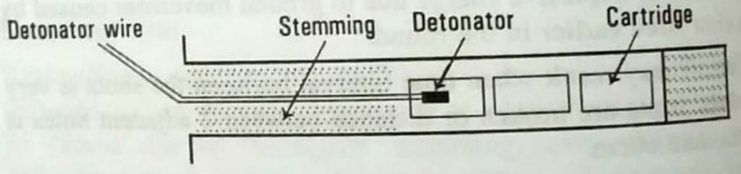


Fig : **Direct Initiation**

The placing of detonator at the back of shot hole is known as **Inverse initiation**. It minimises the danger of cut-off holes. Therefore, it is adopted in delay blasting in stone drifts or in solid blasting which have more chances of blown out shot and cut off.

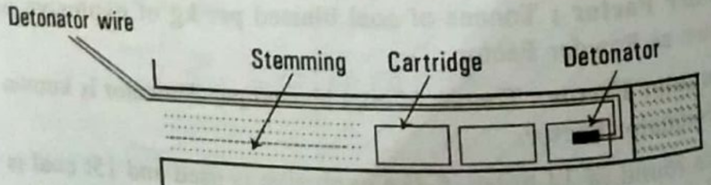


Fig : **Inverse initiation**

Free face

Free face is an exposed coal or rock surface to which the explosive charge can break out. In u.g. mines, free face is provided by under-cut, over-cut or middle-cut by a coal cutting machine, or by driving a narrow heading (*mool*).

In stone drift, sinking shaft and solid blasting in coal, free face is created by using delay detonators. The first few holes of the round (cut holes) are drilled in such a fashion that they break and provide a free face, to which the later holes can break.

Misfire

An explosive charge which has failed to explode after application of electric current is known as misfire. A misfire may be caused by deteriorated explosive or detonator, defective exploder, discontinuity in detonator wire or shotfiring cable, attempting to blast more holes than the capacity of exploder.

When a misfire occurs, cable should be disconnected from the exploder and no body should be allowed to approach the face for atleast 5 min. It is responsibility of shotfirer, to fence the face, to release the misfire by blasting a relieving hole, and to deposit the recovered cartridges and detonators with magazine clerk.

If for any reason he is not able to complete the job, he shall hand it over to the shotfirer of next shift, he shall also write a report in misfire report book.

A cut-off is also to be dealt as a misfire.

Q. 7. What precautions will you take in blasting in a stone drift?

Precautions in blasting in stone drift

1. In a stone drift, there are increased chances of sockets and cut-offs. After shots have been fired, all loose rock shall be removed from the face and the area lying within distance of 1.2m from the face shall be thoroughly cleaned or washed down with water, and carefully examined for presence of misfires or sockets. Unless this is done, the next round of shots shall not be drilled.
2. If any socket is found, it shall be dealt with as a misfire.
3. Blasting shall be done by inverse initiation.

Other precautions

1. Holes shall be drilled accurately as per the blasting pattern.

Time interval between first and the last hole shall not exceed 100ms.

2. Stemming shall be placed to a length of 0.8-1m or upto mouth of the hole.
3. Before blasting, the circuit shall be tested with a circuit tester.
4. On blasting, the material will be thrown to long distances. Hence, cable shall not be shorter than 180m.
5. On reaching within 10m of the coal seam, only permitted explosives shall be used and checks shall be made for methane with an approved methanometer.

Q. 8. Assuming your own conditions, describe with sketches blasting pattern for a stone drift for achieving maximum progress. What type of explosive will you use and what Powder Factor would you expect? (1992)

Assumptions: Drift size 3.6m x 2.4m, strata- hard sandstone and shale. There is no geological disturbance.

Pattern: A wedge cut pattern as shown in the sketch shall be adopted. The 6 cut holes at the centre will be slanting in such a way as to give a pull of 1.4m. Blasting shall be done by 80% special gelatine using delay detonators.

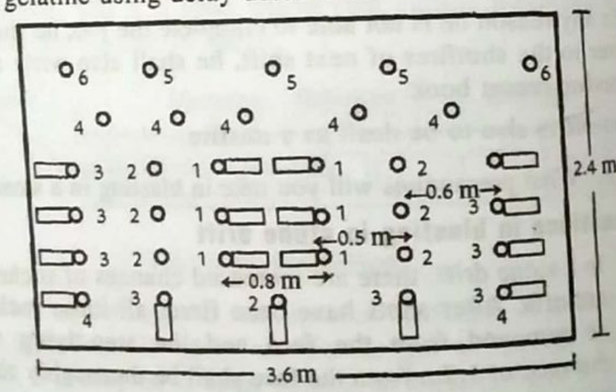
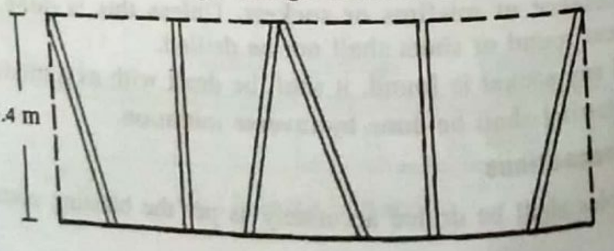


Fig : **Wedge cut in a drift**



	No. of holes	Explosive per hole	Total explosive	Delay number
Cut holes	6	1.2kg	7.2kg	1-6 as shown in sketch
Easers	9	1.0kg	9.0kg	
Trimmers	18	0.9kg	16.0kg	
	33		32.2kg	
Pull	1.4m			

Powder Factor = (3.6 x 2.4 x 1.4)/32.2 = 0.38m^3 per kg

Q. 8. Write a short note on delay detonator giving a sketch.

Delay detonator

Delay detonator is an electric detonator which explodes at a predetermined fraction of a second after the passage of current from exploder. In such detonator, a delay element is provided above the main and priming explosives. By varying the length of delay element, delay detonators with different delays are manufactured.

Millisecond delay detonators are manufactured with delay number 0-6 and with a delay interval between any 2 consecutive delays 25ms. In half second delay detonators, the interval is half second. The delay number is indicated on a plastic tag attached to the detonating wire and is also punched at bottom of the detonator.

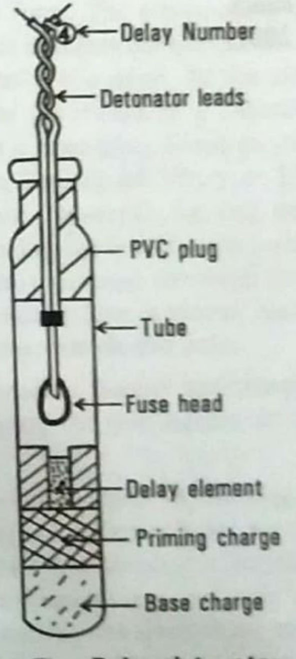


Fig : **Delay detonator**

Delay detonators are used for blasting in stone drifts, sinking shafts, solid blasting and blasting in O/C mines. All holes are connected in one round, but the holes blast in a sequence depending upon the delay interval.

For using delay detonators in u.g. coal mine, permission has to be taken from DGMS and special precautions have to be observed because methane released by an earlier shot may get exploded by a later shot.

Q. 10. Can the mining sirdar incharge of the district fire shots?

Mining sirdar in a mechanised district (using SDL/LHD/road header/BG method) cannot be authorised to fire shots even if the number of persons under his charge is less than 30.

In case of a manually worked district, if number of persons under the official incharge of the district, qualifying to perform the duties of shot firer, is less than 30, he may be authorised to fire shots but not more than half the maximum number that a regular shot firer would be permitted to fire as per Reg.166 (i.e. based on gas degree and type of exploder—single shot or multi-shot).
(Ref. : Cir. Legis. 2/2001)

Chapter 11

BLASTING IN OPENCAST MINES

Q. 1. Describe briefly : Site Mixed Slurry / Emulsion Explosive. (2004)

Site Mixed Slurry/ Emulsion Explosive (SMS / SME)

This explosive is not in the cartridge form. The components of the explosive are carried in liquid form in different compartments of the 'pump truck' from supplier's plant to the mine. At the site, on starting the pump, the components get mixed in a chamber and are pumped into the hole through a hose-pipe. Since mixing takes place at the site, it is known as Site Mixed Slurry or Site Mixed Emulsion. The components are non-explosive and they form explosive a few minutes after being loaded into the holes. Before charging explosive in the hole, a priming cartridge (cast booster 250g or so) tied with a detonating fuse is placed inside the hole. Other end of the fuse remains outside the hole.

Charging rate is about 200kg/min. Specific gravity and strength of explosive can be varied by varying the proportion of the components.

Other operations of blasting are similar to those of blasting by cartridge explosives—detonating fuses of different holes are tied to a common detonating fuse to which a detonator is attached. After withdrawing the pump truck and machinery and men to a safe place, blasting is done by connecting the shot-firing cable and using an exploder. For blasting the holes in a particular sequence blasting relays are used.

Special precautions for SMS / SME

1. Since the explosive is not in cartridge form, permission shall be taken from the DGMS.
2. All blasting operations shall be carried out under the personal supervision of an under manager and an engineer of the explosive supplying company.

3. Smoking, welding or any other open light shall not be allowed within 60m while charging. The ground upto 10m from pump truck shall be free from dry grass.
4. Pump truck shall be kept earthed by chain. Charging hose-pipe shall be of anti-static type.
5. Only minimum number of persons shall be present while charging.
6. For sleeping holes, and for blasting in hot strata, standing permission shall be obtained from DGMS.
7. Primer explosive cartridge shall not be slit or deformed.
8. A sketch of the site showing location of holes, type of strata, burden, spacing, depth, hole dia, quantity charged in each hole, length of stemming, type of explosive, total quantity of explosive used, date and site of blasting shall be prepared by under manager incharge of blasting. A record of results of blasting (fragmentation, flyrock distance, vibration, back break and oversize) shall also be kept.
9. Mine staff engaged shall be given proper training.
10. The supplier shall get pump truck approved by Controller of Explosives once in a year.

Q. 2. What are the causes of blasting related accidents in OC mines? What precautions will be taken to reduce flyrock and ground vibrations? (1999, 2003)

Causes of blasting accidents in OC mines

Three major causes of accidents in OC mines due to blasting are **inadequate shelter, flyrock and misfires.**

1. Inadequate shelter may be due to:
    - Persons in the danger zone taking shelter under truck, dumper, drill, explosive van, tub, asbestos or thatched roofed shelter.
    - Confusion between 'all clear' and 'danger' sirens; persons coming out of the shelter before completion of blasting operation.
    - Inability to effectively communicate commencement and end of blasting operations due to power failure or siren being out of order.

    - Blasting without giving sufficient time for persons to withdraw or without ensuring that all persons have withdrawn to safety.
    - Persons suddenly sneaking into danger zone due to failure to post sentries at all vulnerable places.
2. **Fly rock :** improper burden, spacing, stemming, delay interval between holes/ rows etc. result in fly rock. It may cause injury to men, damage to equipment, power transmission lines, residential and service buildings at distances upto 500m or more.
3. **Misfires :** Misfires are difficult to locate and difficult to deal with. Failure to detect a misfire, may lead to accident by drilling into misfired holes or while loading the blasting material with a shovel.

    Other causes are—

    Premature blasting due to lightning/ storm

    Premature blasting of charged holes while blasting in hot OB

Precautions against flyrock

1. Site of every hole shall be marked on the ground (with depth) by the blasting overman. Burden and spacing shall be adjusted taking into account cracks, crevices, loose strata. Unduly large burden will throw out stemming and cause flyrock. While placing front row holes, shape of the face shall be taken into account. Where there are hard and soft strata, deck charging will be done.
2. Holes will not be over charged.
3. Holes will be stemmed right upto mouth of the hole, but in any case stemming length shall not be less than the burden.
4. Before commencing drilling, patch to be blasted will be dozed to remove loose stones. Boulders will not be allowed to drop into the drilled holes. Loose stones/ boulders act as powerful missiles thrown to long distances.
5. Delay interval between different rows will be carefully chosen. Too long a delay will result in inadequate burden for the back holes. Too short a delay will cause uplifting of the strata and excessive flyrock.

6. All blasting personnel shall be given thorough training.
7. Great care shall be taken in secondary blasting.

Steps to reduce ground vibrations

1. Reducing charge per delay by using delay detonators or detonating relays.
2. Providing a delay interval of 8-10ms/metre of burden between rows.
3. Providing good free face by initiating the blast from one end.
4. Having correct blast geometry (burden, spacing, stemming, hole depth) and drilling accurately.
5. Pre-splitting the last row of holes before final blasting for production.

Q. 3. What is deep hole blasting? What precatuions will be taken in deep hole blasting?

Deep hole blasting

Blasting of holes deeper than 3m in opencast mines is known as 'deep hole blasting'.

Precautions for deep hole blasting

1. Permission shall be taken from the Regional Inspector.
2. *Drilling* :
   - Area to be drilled to be cleared of loose stones.
   - Overman to check for presence of un-blasted explosives and sockets.
   - Overman to mark position of every hole distinctly using measuring tape.
   - Hole to be plugged or covered immediately after drilling to prevent boulders/drill cuttings falling in or persons getting tripped.
   - After drilling, the trailing cable and drill to be withdrawn to a safe distance.
3. *Charging* :
   - Before commencing loading of blast holes, red flags to be strategically placed around the blast area.
   - Only one hole to be loaded at a time.
   - During charging, no person, other than those connected with blasting operation to be permitted within 20m radius or 60m on the same bench.
4. Charging, stemming, connecting up to be done while standing on the solid that is away from the quarry face.
5. *Firing* :
   - (a) Blast holes to be fired during daylight hours and, as far as possible, between shifts or during the rest interval.
   - (b) Time fixed for blasting to be known to all.
   - (c) Holes not be sleeped except when permission for sleeping exists and the prescribed conditions are followed.
   - (d) 30 minutes before firing, the danger zone (a radius of 500m from the site of blasting) to be clearly demarcated (by red flags).
   - (e) Persons to be warned by siren signal and sentries posted to guard strategic entry points.
   - (f) 10 minutes before firing, a siren to be blown 3 times for one minute each, at an interval of one minute.
   - (g) No shot to be fired unless the blasting overman has ensured that all persons, including blasting personnel and equipment have been withdrawn to a safe distance.
   - (h) If there is a public road or railway track within the danger zone, shots to be fired only after traffic has been stopped.
6. *Inspection* : After firing, sufficient time (atleast 5 minutes) to be allowed for dispersal of dust and fumes. The blasting overman to conduct post blast inspection. If all is found to be satisfactory, 'all clear' signal (approved by the manager) to be given which would be distinct from the 'danger signal' and the sentries withdrawn. Under no circumstances, shall any unauthorised person be allowed to approach the blast site until all clear signal has been given.
7. *Supervision* : Preparation of priming cartridges, charging and stemming to be done under personal supervision of the blasting overman, and shots to be fired by him from a blasting shelter located at a safe distance.

8. **During the approach and progress of an electric storm,**
   (a) No explosives or detonators shall be handled.
   (b) *If charging is in progress*, work shall be discontinued until the storm has passed.
   (c) *If charging has been completed*, ends of all detonating cords shall be taped, coiled and placed in mouth of the hole and kept covered with something other than metal plate. Persons shall be withdrawn from danger zone.
   (d) *If connections have been completed*, blasting shall be done at the earliest after withdrawing persons to safety.

Q. 4. What are sleeping holes? What special precautions are taken for sleeping holes?

Or

Write a short note on: Sleeping holes. (2009)

Sleeping holes

Holes which are not blasted on the day when they are loaded are known as 'sleeping holes'.

Holes loaded with explosives are potentially dangerous and must be blasted at the earliest. However, in large O/C mines, sleeping of holes cannot be avoided as very large blasts are conducted involving a large number of holes which take more than a day to load. Sometimes after loading the holes, the nearby equipment cannot be withdrawn to a safe place because of their breakdown and therefore, charged holes remain un-blasted for a day or more.

Precautions for sleeping holes

1. Standing permission has to be taken from the DGMS.
2. Area of loaded holes shall be marked conspicuously by bright red flags during the day and by red light/fluorescent paint at night. Entry to the area shall be effectively cordoned off to prevent inadvertent and unauthorised entry.
3. No smoking, open flame or welding shall be allowed within 60m of loaded holes.
4. There shall always be atleast two rows of holes between holes being charged and the holes under drilling or the drill machine.
5. Holes shall be stemmed immediately as they are loaded.
6. Loaded holes shall be covered by soft stemming material so that the detonating cord end does not remain exposed and there is no danger from static charge/lightning.
7. Connections shall be done only on the day when blasting is to be done, and this shall be done during daylight hours.
8. Sleeping period shall not exceed that permitted by the DGMS. This period usually is maximum 7 days for shovel benches and 15 days for dragline benches.
9. A record of number of holes drilled and loaded date-wise and the date of blasting shall be maintained.
10. Only detonating fuse shall be used in the holes. Electric detonators shall be connected on the surface just before blasting.
11. Blasting shall be done under personal supervision of blasting officer.

Q. 5. What are the dangers associated with blasting in hot strata? Suggest precautionary measures for the same. (2014)

Dangers in blasting in hot strata

- Danger of premature blasting of explosives.
- Danger of misfires

Precautionss

1. DGMS permission shall be obtained.
2. Only slurry or emulsion explosives shall be used.
3. Blasting shall be done with detonating fuse down the hole. Detonator shall not be placed in the hole.
4. Temperature at bottom of blast holes shall be measured and recorded after drilling and every shift thereafter. If temperature of hole exceeds 80^{0} C, it shall not be charged.
5. All holes shall be kept filled with water. A hole traversed by cracks and fissures shall not be charged unless it is lined with an asbestos pipe and the hole filled with water. In addition, bentonite shall be used for sealing cracks at the bottom of holes.
6. Before loading explosives, the detonating fuse shall be cut from the reel.

7. Stemming shall be commenced only after charging all holes.
8. Detonating fuse shall not be laid on the hot ground. It may be placed on a layer of wet sand.
9. Number of holes in a round shall be limited. Charging and firing of holes shall be completed expeditiously and in any case within 2 hours. Holes shall not be sleeped.
10. For stemming, wet stone chips/drill cuttings or wet sand shall be used.
11. Blasting operation shall be under direct supervision of an assistant manager/blasting officer.

Q. 6. What do you understand by 'danger zone of blasting'? Describe a pattern of holes for deep hole blasting in opencast mines. (1992)

Danger zone of blasting

In opencast mine, an area falling within a radius of 500m from the place of firing is called 'danger zone'.

Hole pattern for deep hole blasting

Elements of the pattern are described below :

1. Burden : Burden is the distance of hole from free face or from the nearest hole in next row. It is based on hardness of strata:

hard stone	hole dia x 35
medium hard stone	hole dia x 40
soft strata / coal	hole dia x 45

2. Spacing: Spacing is the distance between two holes in a row. It is also based on hardness of strata:

hard stone	burden x 1
medium hard stone	burden x 1.25
soft strata / coal	burden x 1.5

3. Drilling pattern: This may be –
   - grid pattern
   - staggered pattern

   In grid pattern, holes of different rows are exactly one behind the other. It is used for coal and soft strata.

In staggered pattern, each hole of a row is between 2 holes of an earlier or later row. This pattern is used for medium and hard strata.

4. Sub-grade : In very hard strata, hole is drilled to some distance below the floor of the bench so that toe is not left. This distance is known as sub-grade.

   Usually, sub-grade = bench height x 0.1

   In coal mines, sub-grade drilling is not required because of well-defined bedding planes and strata not very hard.

5. Position of booster : Usually, the booster is placed at bottom of the hole, but where there is water or muck in the hole, it is hung 1 to 1.5m above the bottom.

6. Explosive : Volume of material is calculated as burden x spacing x hole depth. Explosive charge is decided as follows :

hard stone	0.4 kg/ m^3
medium hard stone	0.3 kg/ m^3
soft stone (shale)/ coal	0.2 kg/ m^3

   If there are hard and soft strata in the same bench, deck charging is done. In blasting by SMS, specific gravity of the explosive can be varied according to requirement. Charge per m^3 is decided from a few trials.

7. Stemming height : It should be equal to or more than burden distance. Inadequate stemming causes flyrock and the material does not fragment well.

8. Delay interval : A rough rule is –

hard stone	burden (in feet) x 3 ms
medium hard stone	burden (in feet) x 4 ms
soft stone/ coal	burden (in feet) x 5 ms

9. Initiation pattern : Hole connection / initiation pattern is of 2 types—

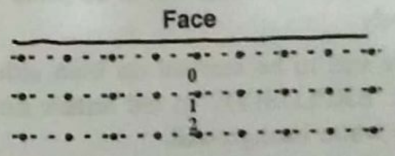


Fig : **Holes in grid pattern; connection in line pattern**

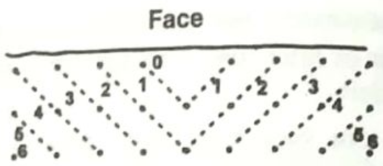


Fig : **Holes in grid pattern; connection in V-pattern**

in-line pattern, where the holes are blasted line by line. This pattern is preferred for soft stone and coal.

V-pattern, where holes of one row are blasted with some holes of the later rows. This pattern is good for hard stone.

A detailed record of blasting parameters and the results obtained is maintained, and based on experience, the parameters are varied to arrive at an optimum blasting pattern.

Q. 7. What precautions are taken in bulk transport of explosives for deep hole blasting in o/c mines?

Bulk transport of explosives

In mechanised o/c mines, large quantities of cartridge explosives and detonators have to be transported from the magazine to the mine or from one magazine to the other. Such bulk transport is carried out by explosives van. Upto 200 detonators can be transported by Jeep or Landrover, but, the detonators shall be kept in a wooden box bolted to wooden frame of vehicle, which shall be placed inside an iron box, and no person shall sit where the explosive is kept.

Precautions in bulk transport

1. Explosive van to be got approved by the Controller of Explosives.
2. Permission to be taken from Regional Inspector.
3. Explosives and detonators not to be loaded together in the vehicle. Quantity transported not to exceed the approved quantity. Explosive cases not to be piled higher than sides of the body.
4. Explosive van to be marked on both sides and ends with the word 'EXPLOSIVE' in red letters not less than 25cm size on a white background.
5. Van to be provided with 2 fire extinguishers (one of dry powder type for petroleum fire and the other of CO_2 type for electrical fire) suitably placed for immediate use.
6. – No person other than the driver and his helper to ride the vehicle.
   - Vehicle not to be left un-attended.
   - Engine to be stopped and brakes applied during loading/un-loading, and while left standing.
   - Speed not to exceed 25kmph.
   - Vehicle not to be taken into garage or repair shop and not to be parked in a congested place.
   - Loaded van not to be re-fuelled except in emergency. During re-fuelling, engine to be kept stopped.
7. Transport operations to be under personal supervision of blasting foreman.
8. Blasting foreman to search every person engaged in loading/transport of explosives, for contrabands.
9. Van to be carefully inspected by competent person once in 24 hours, checking carefully fire extinguishers, insulation of wires, cleanliness, leakage of fuel, lights, brakes and steering. Record to be maintained.

●

Chapter 12

SUPPORT OF ROOF AND SIDES

Q. 1. What is a roof bolt? How does it support the roof? Explain with sketches the method of roof support by roof bolts in a development district. (1999)

Or

What is roof bolting? Explain with sketches how and where it is used. (1994)

Or

Explain with clear sketches the system of roof support in a development district based on roof bolts. (2002)

Or

What is a roof bolt? How does a roof bolt support strata? (2004, 2005)

Roof bolt

Roof bolt is a type of **steel support** which is in the form of a long bolt (atleast 1.5m long). When the bolt is fixed in a hole drilled in the roof and an iron plate (bearing plate) is tightened over it at the roof level with a nut, the strength of strata increases and their sagging is reduced. It is a type of **rock reinforcement system.** Bolts are of many types. For Indian mines cement grouted bolts

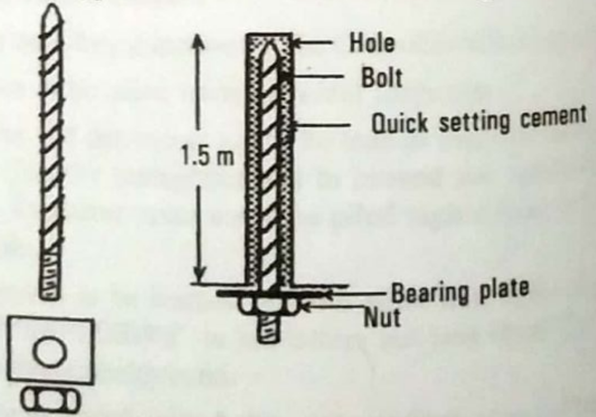


Fig : **Roof bolt**

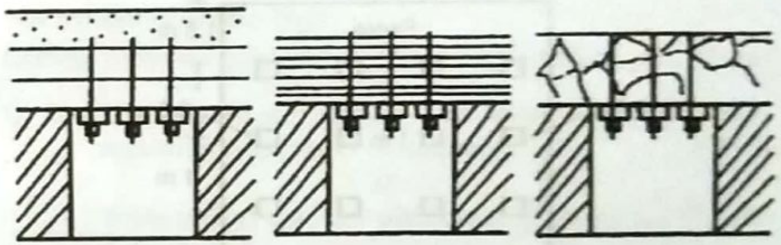
have been found useful except in stressed and watery strata where resin grouted bolts are to be used. Bolts support the roof in 3 ways :

(i) the immediate layers of roof are held by suspensione from a stronger bed above. (*Suspension effect*)

(ii) Bolts clamp several thin layers of roof rocks into a thick beam, which is stronger than the individual layers. If beam is 5 times thicker, strength increases by 5^2 or 25 times. (*Beam effect*)

(iii) Sometimes in fractured or jointed blocks in the roof, a piece of stone is so located that if it is withdrawn, other stones will fall. Bolt prevents such key stone from falling. (Key stone effect). (*Key stone effect*)

In coal mines, bolts serve mostly by beam effect and suspension effect, because coal occurs in sedimentary strata which are layered.



(a) Suspension effect (b) Beam effect (c) Keying effect

Support in development workings

The following places are to be supported as per systematic support rules :

1. Every development working within 10m of face and every junction of roadways immediately outbye of a development face (*freshly exposed roof*).
2. Every working in disturbed or crushed ground (*other workings*).

Pal Committee has recommended :

(a) *for freshly exposed roof* : roof bolts, supplemented by w-straps where necessary. Support at junctions to be increased by 25%.

(b) *for other workings* : roof stitching, supplemented by roof bolting in disturbed areas.

Hole pattern

Hole pattern includes distance between bolts in a row, distance row-to-row, distance of first row from the face, distance of bolts from the gallery sides. Density of bolts is based on *Rock Mass Rating* of the roof strata of the district. A pattern for RMR 50-60, support density 1 bolt per m^2, gallery width 4.2m is shown in the sketch.

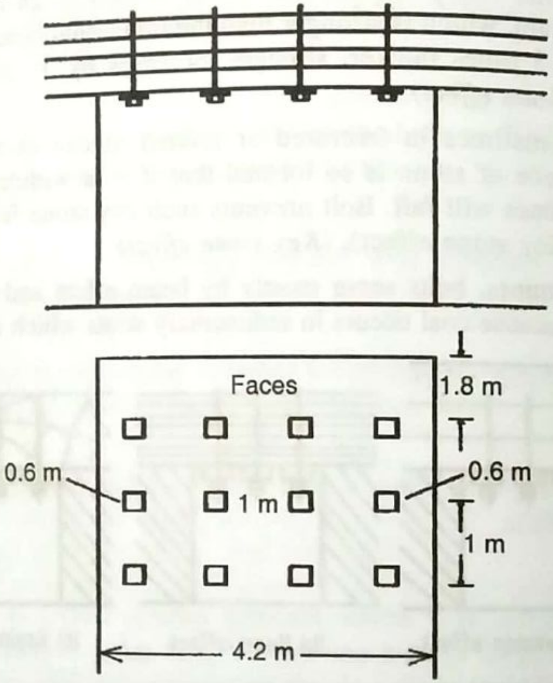


Fig : **Bolting pattern**

Method of bolting

Bolts are installed as soon as the roof is exposed.

1. Drill 1.5m deep holes accurately as per the pattern at 90° to the bedding planes.
2. Soak cement capsules in water until bubbling ceases.
3. Insert 3 capsules in the hole one-by-one tamping firmly by the stemming rod.
4. Insert the bolt into the hole, push it home if necessary by hammering.
5. Fit a bearing plate and nut at the projected threaded portion but do not tighten the bolt.
6. Allow setting time. Then tighten the nut by **torque wrench.**

Anchorage testing : Test 10% of the bolts chosen at random by well maintained and calibrated anchorage testing machine.

The bolt should take 3t load in 30min, 5t in 2hours and 8-10t in 24hours.

Supervision : Bolting to be supervised by overman; anchorage testing by under manager.

Bolt specifications (as per DGMS Circular dt. 13.7.2009) :

Bolt minimum 1.5m long, 22mm dia, of ribbed steel, threaded upto 150m at one end.

Bearing plate a Dome Washer Plate 150 x 150mm x 8mm (minimum) with central hole to accommodate conical seat & nut.

Conical seat.

Nut hexagonal 30mm high

Cement capsule : quick setting type, length 400mm, dia 30mm

Q. 2. What are the provisions of Coal Mines Regulations, 1957 regarding withdrawal of supports? (1999)

Or

Write a short note on: withdrawal of supports. (2000)

Withdrawal of supports

The provisions of regulations are as follows :

Whenever supports are to be withdrawn, withdrawal shall be done in accordance with the method specified in Manager's Standing Orders. The Standing Orders shall cover—

1. supply and use of appropriate *tools* and safety contrivances,
2. setting of *extra supports* to control the collapse of roof from which supports are being withdrawn,
3. *sequence* of withdrawal of supports; withdrawal of a cog to precede withdrawal of its corner props,
4. *safe positioning* of persons engaged in the operation and all persons present nearby,
5. *training* of competent persons who are entrusted with operations, and
6. *supervision* during withdrawal of supports.

Q. 3. Describe hydraulic prop. (1992)

Hydraulic prop

It is a type of steel support which is operated by hydraulic pressure. The prop consists of 2 cylinders—the upper one telescoping into the lower one. A piston-head fitted to the lower end of the top member provides a seal with the inside wall of outer (lower) cylinder. Both cylinders are partly filled with oil.

When a hand-operated pump built into the prop is operated, oil from the upper cylinder goes into the lower cylinder through a non-return valve. This increases the pressure there and pushes the upper cylinder to the roof to give support.

When release lever is pulled, oil pressure in the lower cylinder falls due to flow of oil to the upper cylinder. The upper cylinder comes down. Thus the prop gets opened.

Hydraulic prop has some special features :

1. It has a *high setting load* of about 75% of the maximum. Wooden prop has a very low setting load (0.5t) and it takes more load only as the roof sags.
2. It is fitted with a yield valve which releases the pressure a little when the load exceeds the designed load (*yield load*). Thus, with increase in load, the prop does not break but it continues taking the same load.
3. It can be set quickly, and can be withdrawn from a remote safe position.

A hydraulic prop may take load of 40t. In the past LW faces were supported by hydraulic props. But, these supports are now used only in gate-roads for holding the girders.

Q. 4. What is meant by Systematic Support Rules (SSR)? Describe the related statutory provisions. (2002)

Or

Write a short note on Systematic Support Rules (SSR). (2001, 2003)

Systematic Support Rules

Systematic Support Rules are rules made by the manager for systematic support of roof and sides u.g. as per Reg.108, and approved by Regional Inspector.

These rules are applicable to the following places :

1. Every district in a mine in which extraction or reduction of pillars is going on (de-pillaring district).
2. Every development working within 10m of face and every junction of roadways immediately outbye of a development face.
3. Every longwall working.
4. Workings in a disturbed or crushed ground.
5. Other parts of the mine where in opinion of the Regional Inspector artificial support is necessary.

Method of making SSR

30 days before starting work at a place where supports are to be made as per SSR, the manager shall draft Systematic Support Rules based on physico-mechanical properties, geological conditions, method of working, mechanization and past experience, and send it to the Regional Inspector. The Regional Inspector shall approve the same with or without changes as deemed necessary. These are then applied to the workings in question.

Method of implementation

The manager hands over copies of SSR, together with sketches, to all supervisory officials including assistant manager and under manager, and arranges to post copies at conspicuous places in the mine. He also formulates and implements a code for enforcing the SSR.

SSR specifies the following :

1. type of support
2. support specifications
3. distance :
    - support to support
    - row to row
    - from the face
    - from the side
    - face to pack wall

Q. 5. Discuss importance of RMR of roof rocks in making Systematic Support Rule (SSR). (2014)

Importance of RMR

Systematic Support Rules(SSR) made on the basis of RMR are more reliable than those based purely on judgement and experience of a person.

RMR of roof rocks provides a scientific method of assessing nature of the immediate roof (2 m) because it takes into account :

(a) 5 parameters (with due weightage) on which stability of roof depends, namely,

Layer thickness

Structural features (faults, slips, joints cleats etc.)

Weather ability

Rock strength

Effect of ground water

(b) Difference in rock in different layers

(c) Effect of stresses due to depth, adjacent or overlying workings, method of working, gallery span and lateral stresses.

RMR is used for estimating rock load per sq. m (by a formula) for galleries and junctions. It forms basis of designing the support system.

Experience has proved its reliability.

Q. 6. Write a short note on roof bolting. (1992, 2003)

See Q.1

Q. 7. What are the advantages of roof bolts?

Advantages of roof bolts

1. Bolts act as **'active supports'** i.e. they apply a positive pressure against the roof immediately upon installation. The setting load of a wooden support is very low; it becomes effective only after the roof sags.
2. Bolts can be set soon after exposure of the roof. In highly mechanised districts, roof bolting machines can be used.
3. They do not fall on blasting in faces.
4. Bolts leave enough room for movement of machinery and ventilation.

5. Softness of floor has no adverse effect on roof support.
6. Bolts have long life, and they are light and easy to handle.

Q. 8. What do you understand by Anchorage Testing?
What is the function of bearing plate in roof bolting? (2004, 2005)

Write a short note on anchorage testing of roof bolts. (2014)

Anchorage Testing

Bolts are set in holes by cement or resin grout. The load that a roof bolt can take depends on the grip or anchorage provided by the grout. The process of checking the grip or anchorage of bolts is known as Anchorage Testing.

A wooden prop gives an indication of roof load by bending or cracking or by breaking of the lid. Roof bolts do not give any indication of increasing load and may fail suddenly resulting in roof fall. To check efficacy of roof bolts, 10% of installed roof bolts selected at random are subjected to Anchorage Testing.

Record of Anchorage Testing helps in reviewing and correcting the effectiveness of the bolting system. It is done under personal supervision of an under manager.

Function of bearing plate

Full name of bearing plate is 'load bearing plate'. Bearing plate is an important part of roof bolt assembly. It has 3 functions :

1. It bears the load of the roof layer by supporting it from below, preventing it from sagging or breaking.
2. Upward pressure created on tightening the nut is transferred to a larger area of the roof. This positive upward pressure helps in maintaining the roof rocks in their natural position. Hence, bolts are called 'active supports' also.
3. It prevens the grout coming out of the hole.

Q. 9. Write short note on RMR.

RMR or rock mass rating is a geo-mechanics system of rating stability of immediate roof (upto 2m above gallery height) on the basis of 5 parameters;

	Maximum Rating
Layer thickness	30
Strength features	25

Rock weatherability	20
Strength of roof rock	15
Ground water seepage	10
	100

If there are 2 or more types of roof rocks, combined RMR is calculated. For example, if there are 2 types of thickness 0.8m and 1.2m with RMR 40 and 50 respectively, the RMR of the roof would be :

$$\frac{0.8 \times 40 + 1.2 \times 50}{0.8 + 1.2} = \frac{32 + 60}{2} = 48$$

RMR is also adjusted for depth, lateral stresses, induced stresses, method of extraction and gallery span.

Higher the RMR, better is the roof stability. Roof is categorised as follows :

RMR	*Roof category*
Less than 20	Very poor
20 to 40	poor
40 to 60	fair
60 to 80	good
80 to 100	very good

Q. 10. What steps should be taken to minimise roof and side fall accidents in u.g. mines?

Preventing roof and side fall accidents

1. Freshly exposed roof in development districts should be supported by roof bolts.
2. Method of support shall be designed on the basis of RMR of the roof.
3. Freshly exposed roof shall be supported immediately upon exposure to prevent its sagging.
4. Overman shall ensure that holes for bolting are of correct depth, driven at right angles to the bedding planes.
5. Roof support gang and dresser shall be given intensive training. Adequate number of substitutes shall also be trained, so that in their absence, untrained loaders are not engaged for roof bolting.
6. Bolts shall be of correct dimensions. Threads of nuts shall correspond to those of bolts. Quality of grout shall be ensured.
7. Bearing plate must also be used. Nut shall be tightened with torque wrench after the grout has set.
8. 10% of the bolts shall be subjected to Anchorage Testing and the results shall be analysed to review effectiveness of bolting.

9. The goaf edge in de-pillaring district shall be properly fenced so that nobody can enter it.
10. Attention shall be paid to dressing of overhangs and sides.
11. Supports shall be opened by Sylvester prop withdrawer only.
12. Dressers shall be provided with *sabbal* and bunton of adequate length.
13. In beginning of shift, mining sirdar shall inspect the workings accompanied by support mistry to note supports to be tightened, additional supports to be placed. After blasting he shall inspect roof and sides in the entire danger zone and make it secure.
14. Galleries shall not be unduly widened. Work of clearing the roof falls shall be done in presence of the Overman. Testing and roof support shall start sufficient distance from the fall area. Temporary supports shall be set as required.

Q. 11. Describe with sketches the method of supporting weak shale roof. (1990, 1995)

Method of supporting weak shale roof

Weak shale roof can be supported by special type of roof stitching recently designed by CMRI, Dhanbad.

Two holes 1.5m deep shall be drilled on two sides at the roof level at an angle of 45° using ordinary coal drills. Three more holes of the same depth shall be drilled vertically in the roof at equal intervals in the same alignment. A piece of old haulage rope 20-22mm dia shall be cut with a length = depth of two holes + width of gallery. One end of the rope shall be fixed in one of the side holes with cement grout and a wooden plug shall be hammered to prevent the rope from coming out of the hole. Similarly the other end of the rope shall be fixed in corresponding inclined hole with the cement grout. Now, three j-bolts shall be fixed with cement capsule and wooden plugs in the three vertical holes. While fixing j-bolts, their lower ends shall be anchored to the rope.

When cement is set, wooden sleepers shall be placed between two adjacent ropes as laggings and they shall be tightened by hammering wooden wedges.

j-bolts will strengthen the roof by clamping the roof rocks and the rope will prevent the roof strata from coming down by providing a support from below.

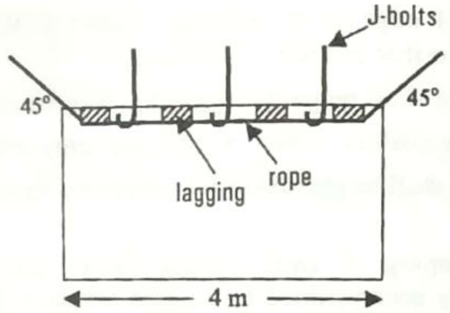


Fig : **Roof stitching**

Q. 12. Explain types of steel supports used in development and de-pillaring districts.

As an Overman of a de-pillaring district, how will you ensure effectiveness of roof bolts installed at faces? (2002)

Steel supports

In development and depillaring district these days, mainly 3 types of support are used:

Pit props

Steel chocks/cog stools

Roof bolts

1. **Pit props**

   Pit props are hollow steel props at the end of which a short length of wood has been hammered. They are light, can be transported easily from one place to another and convenient because their length can be varied easily as required. But they bend easily and if the lower portion does not remain in straight line with the upper portion, the prop does not take proper load.

2. **Steel chocks/Cog stools**

   These are made of 7.2mm x 7.2mm square hollow section steel (thickness 4.8mm) in the form of a cube 900mm x 900mm x 900mm. They are provided with corner plates and are strengthened by welding cross members. Two or more such cubes can be assembled by bolting them together. After installing at the place where support is to be provided, wooden sleepers are placed on them in criss-cross manner upto the roof and tightened by hammering wedges. Where floor is sloping, one or more sleepers are placed below the TISCOG to set it level. They are popularly known as TISCOG because most such supports are made by Tata Steel. TISCOG can take a load upto 50 t. These supports are used in many coal mines. Quality of steel used is as specified by DGMS.

3. **Roof bolts**

   Roof bolts have proved to be more successful than other types of steel supports. They are installed soon after the roof is exposed, are not dislodged by blasting, do not hamper movement of mobile equipment like SDL/LHD, do not hinder ventilation and they cost less. Their use is increasing day by day in both development and depillaring districts. Bolts are usually cement grouted, but where roof is particularly weak (RMR 40 or less) or where there is seepage of water from the roof, bolts are grouted with chemical resin. In some places they are used in conjunction with W-straps also.

They are usually 1.5m long, but where required, roof bolts upto 2.4m long are used. Recently in Indian mines dome shaped bearing plates and conical seats have been introduced in place of plain bearing plates, so that they can take load early and more.

Ensuring effectiveness of roof bolts

1. Overman shall ensure that bolts are installed as soon as the roof is exposed, but in any case not later than 2 hours of exposure of the roof.
2. Holes shall be of correct depth, drilled in proper direction, at distances as per the approved bolting pattern.
3. All materials (bolts, bearing plates, conical seats, nuts, & capsules) shall be of proper quality.
4. Cement capsules shall be properly soaked in water before they are put into the holes. If slow drying and quick drying capsules are used, overman shall ensure that quick drying capsules are inserted in the hole first.
5. Bearing plate shall invariably be fixed and shall be in close contact of the roof. Nut shall be tightened with torque wrench but, only after the prescribed setting time of the grout.

6. Surface of the bolt shall be rid of oil/ grease to ensure proper gripping.
7. The bolts shall be so handled that threads are not damaged.
8. 10% of the roof bolts chosen at random shall be subjected to Anchorage Testing. Testing machine shall be kept properly maintained and calibrated. In case Anchorage Testing is found to be low, the reason shall be found out and corrective measures taken.
9. Overman shall write a detailed report of roof bolting at end of the shift.
10. If there is any deficiency in the material supplied, he shall write a special report.

Q. 13. What do you know about resin grouted bolts?

Resin grouted bolts

1. Resin grouted bolts are similar to cement grouted bolts, but instead of cement grout, a resin grout (chemical grout) is used for fixing the roof bolt.
2. They take more load, dry quickly and serve well even in wet situations. Cement grouted bolts take longer to dry and blasting cannot be done until they are set. They are affected by water as it washes away the cement grout.
3. DGMS has directed to use resin grouted bolts where RMR of roof rock is 40 or less, or where there is seepage of water from the roof.

Q. 14. What are the causes of roof bolt failure? How can bolting failure be prevented – give your suggestions stepwise. (2012)

Causes of roof bolt failure

1. Bolting pattern defective. Pattern not designed on the basis of RMR of roof rocks. Pattern not modified with change in nature of roof.
2. Excessive gallery width.
3. Roof not supported soon after exposure.
4. Defective quality of bolts, threads, nut, bearing plate, capsules.
5. Bolt threads damaged during transit.
6. Wrong drilling–holes too long or too short, in wrong direction, not at proper distance as per design.
7. Incorrect sequence of fast and slow capsules–slow setting capsules inserted first in the hole.
8. Cement capsules not properly made wet.
9. Tightening the nut before the grout has set.
10. Inadequate or non-uniform tightening of the nut because of not using torque wrench.
11. Use of cement as grouting material in watery strata or in weak strata of RMR less than 40.
12. Not keeping a check on efficacy of bolting by anchorage testing.

Measures to prevent failure of bolting

(see Q. 15 below)

Q. 15. What are the essential elements of roof bolting system of an underground coal mine? (2009)

Essential elements of roof bolting

1. **Design** : Thickness and length of bolts, hole dia., hole distance and type of grout shall be decided on the basis of RMR (Rock Mass Rating) of the roof, geological conditions, system of work, mechanisation and past experience.
2. **Width of workings** : Width of workings should be restricted to the width assumed in design calculation, otherwise the bolting system will fail.
3. **Construction and quality of bolts and capsules** : Dimensions of bolt, nut, bearing plate, conical seat, and quality of steel and grout material have been laid down. Bolts and capsules should be checked/tested to ensure that they conform to the laid down specifications. Care should be taken that they are not damaged in transport in the mine.
4. **Drilling and bolting** : If ordinary coal drill is used to drill roof bolting holes, dust falls on the drillers. They are likely to drill less holes per shift and the hole

depth, direction and distances of some holes may not be correct. Mechanised drilling (by UDM, compressed air or hydraulic machine) speeds up drilling and helps in ensuring correct drilling. Bolting system will fail if in some holes bearing plates are not fitted, nuts are not properly tightened or cement/resin capsules are not correctly inserted or are left out.

5. **Promptness in support** : For effective results, bolts should be installed soon after exposure of roof.
6. **Anchorage testing** : Effectiveness of bolting should be checked by anchorage testing of installed bolts chosen at random. The machine used should be of proper design, well maintained and calibrated. In case any deficiency is found by testing, the reason should be ascertained and corrective action taken.
7. **Supervision** : Drilling, bolting and testing should be under supervision of an overman or under manager.
8. **Training** : All persons engaged in roof bolting should be trained and re-trained.
9. **Strata monitoring :** Strata monitoring should be done regularly to keep a check on effectiveness of the support system.
10. **Review of design** : Roof bolting design should be reviewed/modified when there is a change in strata condition, geological condition etc.

Q. 16. Write a short note on timber supports.

Timber supports

Timber supports are heavy, bulky, costly, time consuming, of short life & indefinite strength, and use of timber has involves cutting trees. Therefore they have been replaced by steel supports to a large extent. They are still used in many situations, for example :

- Cogs at goaf edges and junctions.
- Two cross bars on cogs at roof ledges.
- Vertical props with laggings at pillar sides having tendency to spall.
- Inclined stay props to support overhangs.

- Support of faults, slips, breaks in roof by cogs on either side with cross bars across them.
- Support of isolated spots in roadways by props, cross bars or cogs as required.
- As temporary supports.

Statutory requirements for timber supports

- **Props :** diameter atleast 15 cm, set on sound foundation & kept tight against the roof. Lid width not less than prop dia, thickness at least 8 cm, length at least 50 cm. When set on sand, shall be on flat base piece not less than 5 cm thick, 50 cm wide, 75 cm long. Set normal to floor inclination, except in steep floors where prop shall be between the vertical and normal to the floor.
- **Cogs :** made of rectangular sleepers at least 1.2 m long or two opposite sides joggled flat, set on natural floor. With corner props when set at goaf edge or in high galleries.
- **Cross bars :** Supported on props or cogs or in 0.5 m deep holes in sides of pillars. To be provided with laggings and kept tight against the roof.
- **All timber supports :** to be checked after blasting and from time to time, and tightened. To be replaced when deteriorated.
- **Withdrawal** only by safety prop withdrawer.

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Chapter 13

VENTILATION

Q. 1. What are the provisions of the statute on Standard of Ventilation. (1999, 2000, 2001, 2003, 2008, 2014)

Standard of Ventilation

1.(a) **Quantity :** Air passing along the *last ventilation connection*, in every ventilating district, shall be not less than–

$6m^3$/min/person employed in the district in the largest shift, **or**

$2.5m^3$/min/tonne of daily production

whichever is more.

(b) **Quality** : At every place where persons are required *to work or pass*, air shall contain–

O_2 not less than **19%**

CO_2 not more than **0.5%**

no noxious gas likely to affect health of persons.

CH_4 shall be not more than **0.75%** in the *return* of ventilating district and not more than **1.25%** at *any place* in the mine.

(c) **Temperature :** At any *working place* not to exceed **33.5°C** (*wet bulb*).

If it exceeds 30.5°C (wet bulb), velocity of air shall be not less than 1m/sec.

2. To ensure compliance with the above standards, air samples and temperature readings shall be taken atleast once in 30 days and the results recorded.
3. Ventilation shall be produced by mechanical ventilator.
4. Respirable air borne dust at any working place shall not exceed $3mg/m^3$ air.
5. Air velocity shall not be less than that prescribed in Reg. 136A.

Note : 1. If any special circumstances exist, DGMS may relax the above standards.

2. Ventilation complying with the above standards is called 'adequate ventilation'.

Q. 2. What are the provisions of regulations regarding standard of ventilation in degree 3 gassy mine? (1990)

Standard of ventilation in deg.3 gassy mine

Note : After giving the answer as in Q.1, add :

Velocity of air shall be atleast as follows :

4.5m from face (on intake side of partition)	45 m/min
7.5m from discharge end of air duct	25 m/min
At maximum span of L/W face	75 m/min

In a degree I or II mine, these figures will be 30, 15 & 60 respectively.

Q. 3. What is meant by splitting and coursing of air? State the guiding rules for both.

Splitting and Coursing of air

Spliting means dividing air entering the mine into a no. of parts and sending one part to every district so that all districts have independent ventilation.

Coursing means directing the air from the nearest connection to the face by a brattice/pvc/corrugated sheet partition or by auxiliary fan with tube.

Rules for splitting and coursing

1. Air entering the mine shall be split up into a no. of parts and sent to different districts.
2. Each district in Deg.II/III seam or fiery seam, shall have two intake airways, one of these shall be used as a travelling roadway.
3. Intake air shall be so arranged as to travel away from stagnant water.
4. Air passing from a goaf or old working shall not be taken to the face.
5. Any connection between a main intake airway and a main return airway shall be provided with *atleast* two doors (3 as per recommendation of New Kenda Court Of Inquiry),

so spaced that when one is opened, the other can be kept closed. Steps shall be taken to ensure that at least one of the doors is always closed. If the connection is not required, it shall be sealed.

6. Air shall be so coursed that velocity is not less than the following :

	Deg.I&II	Deg.III
4.5m from face (On intake side of partition)	30 m/s	45 m/s

7. 'main drivage' (*mool*) shall not be kept more than 3m ahead of the face of the main heading.

Q. 4. State the statutory provisions regarding ventilation stoppings.

Provisions regarding ventilation stoppings

1. Sufficient number of ventilation stopings shall be provided and maintained to ensure adequate ventilation at all working places. (pucca stoppings shall be kept up-to-date).
2. Every stopping between the main intake and main return airway shall be constructed of masonary or brickwork, not less than 38cm thick (as directed by the DGMS). This thickness shall be at the roof of the roadway.
3. To prevent leakage, ventilation stoppings shall be constructed after making proper 'khanja' (foundation) in roof, floor and sides, and the stopping shall be plastered with a thick coat of lime or cement plaster.
4. Stopping shall be well maintained to prevent leakage of air. Strata surrounding the stopping shall be kept leak proof.
5. If a hole is made in a stopping for crossing a pipe or cable, it shall be closed as soon as the job is done to prevent leakage of air.
6. Approach to every ventilation stopping shall be kept easily accessible, and without any obstruction. It shall be kept well supported. If there is likelihood of accumulation of water behind the stopping, a water seal shall be provided.
7. All ventilation stoppings shall be inspected atleast once in every 14 days by a competent person (overman/under or asstt manager) and the results shall be recorded by him in bound paged book kept for the purpose.

Q. 5. What is the purpose of installing ventilation doors in a mine? State the statutory provisions for ventilation doors.

Ventilation door

When a connection is required between an intake and a return airway for passage of men, tubs and materials, a ventilation door is provided in the connection to prevent intake air short circuiting to the return. (generally it is a set of 2 or 3 doors.)

Statutory provisions regarding doors

1. Space between frame of ventilation door and the roof and sides of the roadway should be built up with masonary or concrete not less than 25cm in thickness.
2. The door shall be self closing. (This can be easily achieved by arranging the door to open towards the intake and keeping the top of the door frame tilted (5 to 10°) in opposite direction to opening by off-setting by 3 to 5 cm.
3. Whenever door is opened, it shall be closed as soon as possible, and shall not be propped or fixed so as to remain open. Dust and dirt shall not be allowed to accumulate near the door.
4. If door is required to be frequently kept open for passage of men materials, a door-attendant shall be posted throughout every working shift.
5. It a door is not in use, it shall be taken off its hinges and placed in such position that it shall not cause any obstruction to the air current.
6. A connection between a main intake airway and a main return airway shall be provided with atleast two doors (3 doors as recommonded by the New Kenda Court of Inquiry) so spaced that whenever one door is opened, the other door can be kept closed. It shall be ensured that at least one of the doors is always closed.
7. No inflammable material shall be used in construction of the door.
8. Door shall be maintained in a proper working order.
9. Atleast once in every 14days, a competent person (overman or under manager) shall examine every ventilation door, and record the results in a bound paged book kept for the purpose.

Q. 6. Write short notes on : (1985, 1988)

(a) Air Crossing

(b) Regulator

(c) Surface Airlock

Air Crossing

1. Where a return airway crosses an intake airway, an air crossing is built. If one airway in deflected over the other, the crossing is called an 'overcast'. If it is deflected under the other, it is called an 'undercast'. Undercasts are uncommon because water may accumulate.

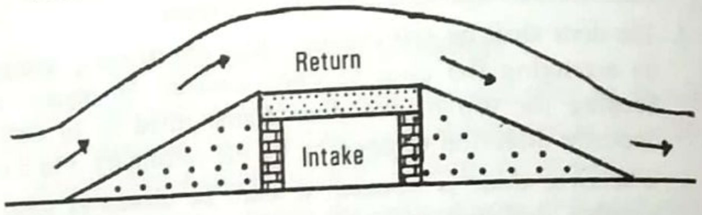


Fig : **Air Crossing**

2. According to Reg.146, every air crossing is to be explosion proof. In such an air crossing, roof of the lower airway (intake) is heightened and a false roof made of reinforced cement concrete 30cm thick, reinforced with girders 15cm x 8cm and wires. Side walls of the lower airway are built not less than 75cm in thickness.
3. Area of cross section of either airway is kept not less than 9.3 m^2 (100sq.ft).
4. The back of intake walls is solidly packed with debris, free from inflammable material, to give a slope not steeper than 1 in 3 to the floor of the return airway.
5. Both the roadways are kept well supported.
6. Air crossing is maintained from time to time to keep it leakproof.
7. It is inspected atleast once in 14days by a competent person (overman or asstt/under manager) and the results recorded in a bound paged book kept for the purpose.

Regulator

Regulator is a stopping with a window which is provided with a sliding shutter for regulating the size of the opening. The shutter is usually made of a steel plate sliding in a set of horizontal or vertical channels built in a frame fitted in the brick stopping.

A district near the shaft-bottom gets air in excess of its requirement while a district at a long distance from the shaft gets insufficient air. Regulator is built in the nearby district to restrict the air quantity so that air quantity in the distant district is increased.

The sliding shutter has a locking arrangement to prevent tampering .

Regulator is installed in the return airway of the district being regulated. Being an artificially created constriction, it has an adverse effect on the quantity of air entering the mine.

Like any other ventilation control device, it is also to be inspected by a competent person atleast once in 14days, and maintained properly.

Surface Air lock

An airlock is needed at the surface of every upcast shaft which is used for winding men and materials. If airlock is not provided, air will not be sucked from the mine (in case of an exhausting fan) but it will come through the shaft mouth.

Earlier in most of the Indian mines, the airlock consisted of a simple circular covering, made of wood or iron sheets, placed on top of the shaft which was lifted by the upcoming cage. This caused heavy leakage of air, even upto 40% of air circulated by the fan.

In 1966, DGMS advised use of German type airlock or steel box type airlock. Some mines have installed such airlocks.

German type airlock : Top of the shaft is covered leaving two openings for the cages. Each opening is kept closed by an aluminium box, which is lifted by the upcoming cage. To prevent leakage when top of the cage starts lifting the aluminium box, a rectangular hollow box is fitted rigidly below each opening. This type of airlock is provided at Chinakuri 1 & 2 Pit Colliery.

Steel box fitted in the headgear : In this also the shaft top is closed except for two openings for cages. Each opening is covered by a sheet steel box closed at the top and fixed in the headgear. It has a drop door at decking level which is lifted by the upcoming cage, and it drops down when the cage goes down. This type of airlock in provided at Sudamdih Colliery.

Airlock is a major source of air leakage. Leakage can be controlled by provision of one of the above two types of airlocks.

Q. 7. Describe briefly :
VEQ (Ventilation Efficiency Quotient). (2004)

VEQ

1. Volumetric Efficiency Quotient (VEQ) is the ratio of quantity of air reaching the last connection in the district to quantity entering the district. i.e.

$$\text{VEQ of district} = \frac{\text{Air quantity reaching the last connection in the district}}{\text{Air quantity entering the district}}$$

2. VEQ should be worked out for every district when air quantities are measured and recorded in the air measurement book.
3. VEQ depends on the workmanship in building the stoppings, air crossings and doors, quality of their maintenance and no. of stoppings alongside the airway.
4. Normally VEQ should not be less than 85% for 30 stoppings.
5. VEQ of mine

$$= \frac{\text{Sum of air quantities reaching last connections in all districts}}{\text{Quantity entering the mine}}$$

It depends on leakage of air through fan house, surface air lock, stoppings, doors and air crossings, due to poor construction and poor maintenance.

Stoppings not up-to-date, holes in stoppings for passing pipes/cables not properly sealed are some other causes of low VEQ. Mine VEQ in Bord & Pillar workings is generally 40 to 50%.

Q. 8. As an Overman incharge of an underground district, what action will you take in the following circumstances and why—
The main mechanical ventilator remains stopped for more than 30 minutes. (2004)

Action by overman on stoppage of main mechanical ventilator

On getting information of stoppage of main mechanical ventilator from the attendance clerk or otherwise coming to know of it, overman incharge of the district shall take the following actions :

1. All workmen shall be withdrawn from faces to nearest main intake airway at least 270 m away from the nearest working face.
2. Electric power shall be cut off.
3. If the ventilator starts *within one hour* of the stoppage-
   - the overman shall check all faces for inflammable and noxious gases, adequacy of air and safety.
   - if an auxiliary fan is used, he shall restart the fan after checking for gas at the site, and shall check the faces after it has run for some time.
   - when faces are found safe, electric power shall be restored and workers shall be allowed to proceed from the place to which they had been withdrawn.
   - he shall send information of resumption of work in writing to the senior official present belowground or to the manager.
4. If the stoppage *exceeds one hour*
   - the overman shall withdraw all persons to surface.
   - officials, pump khalasis and persons employed on urgent repair work shall remain belowground if the manager is satisfied that the places where they are to work or pass are adequately ventilated during stoppage of the ventilator and gives an order in writing.
   - when the ventilator restarts, all working places shall be examined by the overman or mining sirdar as in the above case and information given to the manager. Order for general resumption of work shall be given by the manager.

5. The overman shall write a report of the stoppage in the dangerous occurrences report book.

Q. 9. Describe briefly : (a) Anemometer (1978, 1987)
(b) Velometer

Anemometer

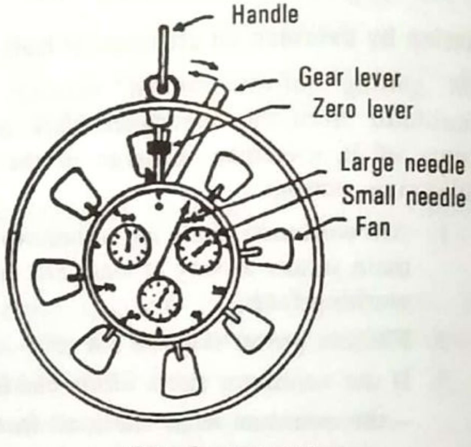


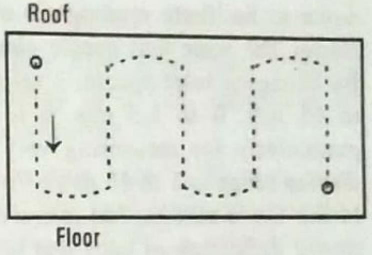
Fig : **Anemometer**

Anemometer is an instrument which determines the distance travelled by air in a given time, and is used to find out velocity of air in a mine readway. Velocity multiplied by area of cross section of roadway gives the quantity of air flowing.

A commonly used type of anemometer consists of a fan of 100mm dia having its vanes at 40° to 45° to the direction of the airflow. When held in a roadway, the travelling air rotates the fan, and through gearing arrangement, the needles of 3 small and a large dial of anemometer show the distance travelled. Other parts of the instrument are a clutch for engaging and disengaging the levers, a zero setting lever for bringing the needles back to zero after taking a reading, a handle at the top for carrying the instrument, and a threaded hole at the bottom to receive a stick-holder, about one metre long, for holding the instrument away from the observer.

The instrument is suitable for measuring velocities from 1 to 15m/ second. It is provided with a correction chart showing the correction to be applied to observed velocity in metre/second to get correct velocity.

To measure air velocity, the observer holds the instrument in the middle of a uniform stretch of roadway, When vanes are revolving freely, an assistant holding a stop watch gives a command to engage the lever and simultaneously starts recording the time. The observer traverses the instrument slowly up and down to cover the entire cross-section. After a certain time, 2 to 3 minutes, the assistant gives a command to disengage the lever and simultaneously stops the stop watch. The observed reading is divided by the time to get velocity of air in metres/second to which correction factor in applied to get the correct air velocity.



The instrument is delicate and needs to be handled carefully. From time to time, it is sent to the Central Institute of Mining & Fuel Research (CIMFR), Dhanbad, for recalibration.

In a modern version of the instrument, rotations of the fan are recorded by a photo electric counter and the air velocity is displayed in numbers. (Digital anemometer).

Velometer

Velometer indicates air velocity in metre/sec at any point of observation, while anemometer gives average velocity over a period of time. To find air velocity in mine roadway by velometer, readings are taken at a no.of equally spaced points over the cross section, and the average is calculated.

The instrument consists of an aluminium vane mounted in jewelled bearing in a bakelite case. When held in the roadway, air deflets the vane. Deflection is proportional to air velocity. It is shown by the pointer on the scale in m/s. The mechanism is spring balanced so that the instrument can be tilted or held upside

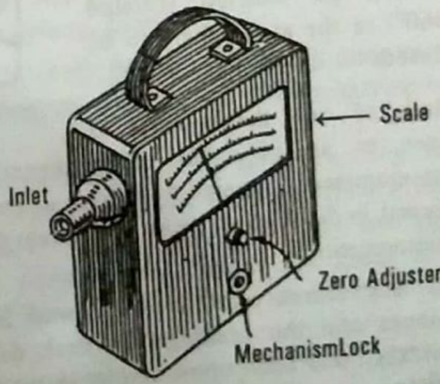


Fig : **Velometer**

down to facilitate readings in awkward places. By operating a clamp, the vane and needle can be locked in reading position. By changing inlet nozzle, 3 velocity ranges can be obtained : 0 to 15 m/s, 0 to 1.5 m/s, 0 to 0.5 m/s, Velometer is useful, particularly for measuring very low velocities. (anemometer's display range is 1 to 15 m/s). Velometer manufactured by Nanda Millar Co. Kolkatta, has micro circuits and electronic device to record deflection of vane and to display a reading on a meter.

Velometer is sent to CIMFR once a year for re-calibration.

Q. 10. Write a short note on :

(a) Hygrometer (1993)

(b) Barometer

(c) Barometric pressure and its effect on sampling of mine air. (2005)

Hygrometer

Hygrometer is an instrument for measuring relative humidity of air. The hygrometer commonly used in mines is a Storrow whirling hygrometer. It consists of two thermometers (15cm long) mounted side by side on a wooden frame and fitted with a loose handle so that it can be whirled (rotated 360°) in the atmosphere to be tested.

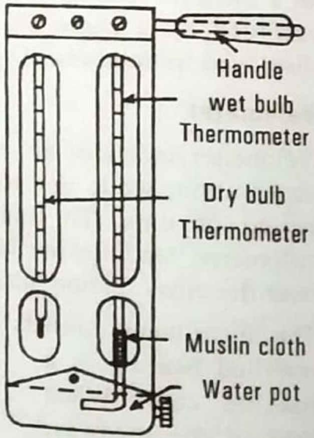


Fig : **Hygrometer**

Bulb of one thermometer is open to air (dry bulb thermometer). Bulb of the other thermometer is covered by a piece of muslin cloth whose end is dipped in distilled water in a container fitted below it (wet bulb thermometer).

The instrument is whirled at about 200 rpm for about one minute and the readings on both thermometers are taken quickly. Wet bulb thermometer is read first as it is likely to change.

Hygrometer is used–

- to measure relative humidity near every fire stopping regularly; a rise in humidity gives an indication of development of spontaneous heating.
- to measure wet bulb temperature once in 30 days at all working places in the mine. Wet bulb temperature should not exceed 33.5°C. If it exceeds 30.5°C, a velocity of air atleast 1m/sec is to be ensured.

Note : Rotation at 200 rpm gives a relative air velocity of 3m/second around the thermometers. If it is not rotated, low temperature of the wet bulb and the moisture evaporated around it will vitiate readings of the dry bulb thermometer.

Barometer

Barometer is an instrument for measuring pressure of the atmosphere. The type commonly used at mines is Fortin barometer. It consists of a thin glass tube (inside dia 8mm) about 920 mm long whose upper end is sealed and the lower open end is dipped into a mercury vessel.

The mercury vessel is made of boxwood with a soft leather base. It sits on a metal plate which can be raised or lowered by a screw fitted below it to adjust the level of mercury in the cistern. The glass tube is protected by a brass tube.

Before a reading is taken, level of mercury is adjusted so that its surface just touches the tip of an ivory pointer, which is in level with zero of the barometer scale. This enables the scale on brass tube to read height of the mercury column directly.

As advised by the DGMS, every fiery or depillaring mine or a mine having sealed workings must be provided with a barometer at the surface.

Every overman must note barometer reading before entering the mine, because when atmospheric pressure falls rapidly, noxious gases of goaf or sealed off area expand and erupt into the workings, necessitating more careful checks for gases and withdrawal of workmen from the district in severe cases. If pressure rises rapidly, the gases contract and air enters the goaf and sealed off areas increasing chances of spontaneous heating and fire.

Barometric pressure and its effect on drawing air samples

Barometric pressure or atmospheric pressure at any point is the weight of the column of atmospheric air per unit area over that point. It changes with elevation and meteorological conditions. The atmospheric pressure is measured by a mercury barometer. At mean sea level and 0°C temperature, the mercury barometer reads 760mm.

When atmospheric pressure falls rapidly, noxious gases of the goaf and sealed off areas expand and escape into mine workings, necessitating more frequent checks and withdrawal of workmen from the district in severe cases. If pressure rises rapidly, air leaks into the goaf and sealed off area increasing chances of spontaneous heating / fire. A barometer is therefore provided in manager's office in every fiery and depillaring mine. Overman notes trend of barometer reading before entering the mine.

Effect on sampling of mine air :

Barometric pressure has much effect on mine air sampling. From a sealed off area, air samples are drawn when pressure in the sealed off area is positive. A positive pressure is most likely to exist when barometer reading is steady or falling. When pressure inside is negative, air sample can be drawn by using air pump but the results are likely to be inaccurate as air leaks from outside and the atmosphere near the stopping is diluted. Whether the atmosphere inside is positive or negative is known by connecting a water-gauge to the sampling pipe.

Q. 11. State briefly provisions of the regulations regarding auxiliary fans. (1997)

Auxiliary Fan

1. • Every auxiliary fan shall be so located/installed/worked that :
   - sufficient air reaches it at all times to prevent recirculation.
   - there is no risk of air circulated by it containing substantial quantity of inflammable or noxious gases or dust.
   - • It shall be kept earthed to avoid accumulation of electrostatic charge.

- • It shall be provide with ducting upto 4.5m of the face.

2. Starting/stopping, alteration, shifting shall be done by authorised persons only.
3. No person shall enter or remain in any place ventilated by auxiliary fan, when the fan stops. After restart, competent person shall examine for gas etc. before allowing persons to enter.
4. In any fiery seam or gassy seam of 2nd or 3rd degree, two or more auxiliary fans shall not be installed in the same ventilating district without permission of Regional Inspector.

Note : Auxiliary fan is used for one or more faces of a ventilating district.

Booster fan is used to boost air current of the whole mine or a whole ventilating district.

Q. 12. What is an auxiliary fan?

What precautions are required to be taken in using more than one auxiliary fan in a ventilation district? (1994)

Auxiliary Fan

It is a small forcing fan or an exhausting fan, installed underground for ventilating one or more faces of a ventilating district or for ventilating a stone drift. It is used for coursing air from the nearest connection to the face. It is used with steel, pvc or canvas ducting of 500 to 600mm dia.

Two auxiliary fans in one district

If two or more auxiliary fans are used in the same ventilating district, the following precautions shall be taken :

1 (a) Auxiliary fan shall not take more than 50% of air passing in the roadway.

(b) Air taken by auxiliary fan shall not contain inflammable gas more than 0.3% or excessive dust. Every time before starting a fan, this shall be ensured by an overman or other official.

2. A forcing fan shall be installed on the intake side of the heading and the exhaust fan on return side of the heading. Distance of fan from the nearest pillar corner shall not be less than 4.5m.

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2. A forcing fan shall be installed on the intake side of the heading and the exhaust fan on return side of the heading. Distance of fan from the nearest pillar corner shall not be less than 4.5m.

3. Electrical switches of the fans shall be interlocked. A fan on return side shall be started only if fan on its intake side is working satisfactorily.
4. No person shall be allowed to enter a heading whose ventilation is dependent on auxiliary fan until the overman has found air at the face to be adequate and its return air does not contain more than 0.5% methane.
5. As soon as an auxiliary fan stops, men shall be withdrawn from the face and power shall be cut off. Power shall be restored only when fans are running properly. If the fan remains stopped for a long time, sufficient time shall be allowed for gases to clear and power shall be restored only after the overman has checked that methane in the return air of the face is not exceeding 0.5%.
6. All fans shall be kept earthed.
7. Air ducts shall be so maintained that leakage is minimum and adequate quantity of air reaches within 4.5m of the face.

8.(a) Once a week ventilation officer shall measure quantity of air reaching the fan, and percentage of methane in it, and check that with the fans running, ventilation at the face is adequate. Such measurements shall be done before installation of fans also.

(b) District overman shall write a report of any stoppage of fan during his shift.

Q. 13. **What are the different methods of coursing of air to a running face? What arrangements will you make for ventilation of a single long heading in a gassy seam?**

Methods of air coursing

Air entering the mine is split and sent to different districts by building stoppings, doors and air crossings. In the district, air is coursed to faces by–

1. barricades of fire-resistant brattice or pvc sheeting nailed to wooden props placed at 1 to 1.5 m intervals along the heading, or
2. barricades of CGI sheets (corrugated iron sheets) nailed to wooden props, or
3. auxiliary fans with steel pipes or flexible ducting on
   (a) forcing system,
   (b) exhaust system, or
   (c) overlap system (using 2 fans : forcing ventilation with exhaust overlap, or exhausting ventilation with forced overlap).

Air coursing in a single long heading in gassy seam

Since the seam is gassy, dilution of methane at the face would be the major consideration. For a long heading (upto 1km), from the above 4 systems 'simple forcing system' shall be preferred.

It will consist of an axial flow fan of suitable capacity installed about 9m on intake side of the entrance and a flexible ducting which shall be kept extended upto 5-7m from the face. If quantity Q is required at the face, the fan should draw 1.4Q air (allowing 40% leakage). The fan shall draw not more than 50% of air flowing in the main roadway. As such at the mouth of the drivage, 2.8Q air shall be made available.

A typical arrangment for delivering about 3.5 m^3/s air at the face of a 800-1000m heading may require forcing fan of 15kw with 750mm flexible ducting.

Other arrangements

1. Before installing the fan, air quantity at mouth of the heading shall be measured. It shall be ensured that it is sufficient to arrange dilution of gas in the heading upto a maximum of 0.5%.
2. The system shall be kept earthed to avoid accumulation of electrostatic charge.
3. Ducting shall be maintained to keep leakage to the minimum.
4. No person shall enter or remain in the heading, unless the fan is operating efficiently. If the fan stops, men shall be withdrawn and they shall not re-enter until the fan runs for some time, and the place has been examined by a competent person and declared to be safe.
5. Operation, alteration/shifting shall be done by authorised persons only.
6. Air quantity at the face and at mouth of the heading shall be measured weekly.

7. Chances of raising dust in air will be reduced by discharging air from the duct through a diffuser.

This simple forcing system has several **advantages :**

- it delivers fresh and dry air at the face,
- air coming out of the duct at high velocity will remove the gas by scouring/mixing at the face,
- fan motor remains in the intake,
- the system is simple and cheap; unsupported pvc or flexible ducting, light in weight and having low resistance to air flow can be used.

Forcing system has a disadvantage that blasting fumes may take upto one hour to clear, but on the whole the system is useful. However, if the heading is to be driven by a road header, 'exhaust ventilation with forced overlap' may be preferred.

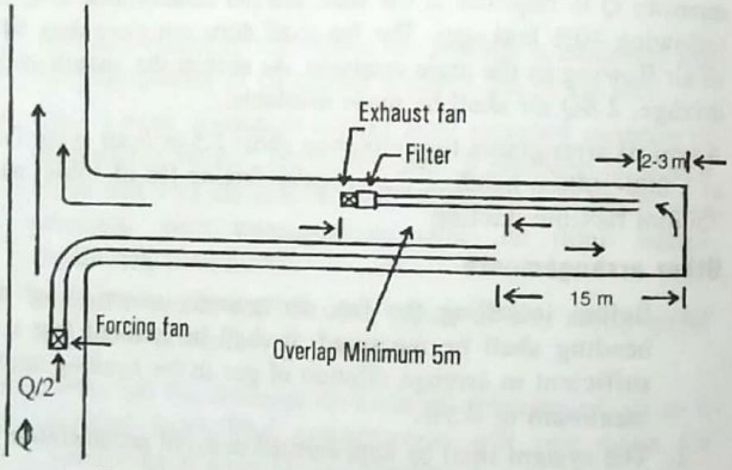


Fig : **Forcing ventilation with exhaust overlap**

Q. 14. Write a short note on :
Interlocking of auxiliary fans. (2008)

Interlocking of auxiliary fans

If two or more auxiliary fans are installed in a ventilating district, the fans shall be electrically interlocked by a sequence control which ensures that a fan will not start, unless the fan on its intake side is running.

If intake side fan is not running and the return side fan is started, air entering it shall contain a high quantity of coal dust and methane.

Chapter 14

VENTILATION NUMERICALS

Q. 1. What is the minimum quantity of air required to ventilate an u.g. district producing 150t of coal per shift employing a maximum of 100 persons in a shift.

According to the regulations, quantity of air in the last ventilation connection of the district should be

(i) minimum $6m^3$/min per person employed in the district on the largest shift, or

(ii) minimum $2.5m^3$/min per tonne of *daily* output of the district,

Whichever is greater.

Here, no. of men employed in the largest shift = 100

∴ minimum quantity based on manpower = 100 × 6
= $600m^3$/min ...(1)

Daily (3 shift) output of the district = 150 × 3 = 450t

∴ minimum quantity based on coal production = 450 × 2.5
= 1125 m^3/min...(2)

From (1) & (2), the minimum quantity of air required in the last ventilation connection would be 1125 m^3/min.

Q. 2. What is the minimum quantity of air required for ventilating a district producing 150 tonnes coal and employing 75 persons in the latgest shift? (1997)

On the basis of manpower

Air required per person $6m^3$/min

Persons employed in the largest shift = 75

∴ Minimum air required = 75 × **6** = 450 m^3/min ...(1)

On the basis of production

Production per shift = 150t

Daily production = 150 × 3 = 450t

Air required per t of daily output = $2.5m^3$

∴ Air required = 450 × 2.5 = $1125m^3$/min ...(2)

From (1) & (2), we see that the minimum quantity of air required in the last ventilating connection of the district would be 1125 m^3/min.

Q. 3. An anemometer gave reading of 250m in 5 minutes. The gallery was 4.2m wide and 2.5m high. Calculate the quantity of air flowing. (1995)

Quantity of air per minute, Q = A × V

where A = area of cross-section of roadway, in sq. metres

V = velocity of air, in metres per minute.

A = width × height

= 4.2 × $2.5m^2$

= 10.5 m^2

$$V = \frac{250}{5} = 50\text{m/min}$$

∴ Q = 10.5 × 50 = 525 m^3/min

Q. 4. In a 300m long drift, 4.8m wide and 2.5m high, anemometer gave a reading of 100m in 2 minutes. Calculate the quantity of air flowing in the drift, in cu. metre per minute. (1992)

Quantity of air Q = A × V m^3/min

where A = area of cross-section, in m^2

V = velocity of air, in m/min.

A = width × height

= 4.8 × 2.5 = $12m^2$

V = 100 ÷ 2 = 50 m/min

Q = 12 × 50 = $600m^3$/min

Note : Length of drift is not required for the calculations.

Q. 5. An anemometer shows a reading of 90m in 2 minutes in an airway 5m wide and 3m high. Calculate the quantity of air flowing. Assume the correction factor shown in correction chart is + 6.

Anemometer reading for 2 minutes = 90m

Anemometer reading for one minute = 90 ÷ 2 = 45m

Correction factor is + 6

Hence, correct anemometer reading for one minute = 45 + 6 = 51m

It means velocity of air = 51 metres per minute

Area of cross section of airway = 5 × 3 = 15 m^2

Quantity of air = Area of cross section × velocity of air

= 15 × 51 m^3 per minute

= 765 m^3 per minute

Note : The correction is to be applied to velocity of air per minute and not to the reading of the anemometer.

Q. 6. In a main airway a quantity of $950m^3$/min of air is flowing. At a point 700m inbye the velocity of air is 65m per minute, and the height and width at that point are 2m and 4m respectively. How much air is leaking through the stoppings and doors between the two points? (1985)

Quantity of air at the first site = $950m^3$....(1)

700m inbye

Velocity of air V = 65m/min

Area of cross section of the roadway, A = 2 × 4 = $8m^2$

∴ Quantity of air, Q = V × A

= 65 × 8 = $520m^3$/min ....(2)

Quantity of air leaking through the stoppings and doors between these two points = 950 – 520 = $430m^3$/min.

Q. 7. $350m^3$/ min of air is entering a district but in the last ventilation connection air is found to be only 300 m^3/ min. Calculate VEQ of the district.

Ventilation Efficiency Quotient or VEQ of the district

$$= \frac{\text{Air Qnty. reaching the last connection}}{\text{Air Qnty. entering the district}} \times 100\%$$

$$= \frac{300}{350} \times 100\%$$

= 85.7%

Chapter 15

MINE GASES AND GAS TESTING

Q. 1. Name the noxious gases entering mine air. How can they be detected? State their maximum permissible limits.

Noxious gases, their detection and permissible limits

Noxious gases entering mine air and their permissible limits are as follows :

	Permissible limit
1. Carbon monoxide (CO)	50ppm (0.005%)
2. Carbon dioxide (CO_2)	0.5%
3. Nitrous fumes (NO,NO_2 N_2O_4, N_2O_3 mixture or NO_x)	5ppm
4. Hydrogen sulphide (H_2S)	7ppm (0.0007%)
5. Sulphur dioxide (SO_2)	7ppm (0.0007%)

For detecting their presence, regular inspections of the mine are done.

Detection

CO – 2 to 3 *lal munias* are taken to the place where gas is to be detected. At 0.15% CO, the birds show restlessness (by flapping of feathers, chirping, loss of activity) and fall off the perch in 18 minutes. At 0.3% CO, the birds become restless almost immediately and fall off the perch in 2 to 3 minutes. The method is not reliable in low levels of CO concentration, but it is a good indicator at high concentrations.

– CO can be tested by P.S. detector or Draeger multigas detector, by using appropriate glass tube containing a chemical whose colour changes in presence of CO. Gas concentration is found by matching the colour with the chart provided on the instrument.

– CO can be tested by Oxymeter/Toximeter also using appropriate electrochemical sensor. It gives an alarm also.

CO_2 – CO_2 or blackdamp (oxygen deficient air) are found in large quantity in poorly ventilated workings, sealed off old workings and goaves. On fall of barometric presure, the gas overflows into the workings, It can be tested by flame safety lamp (FSL). For every 1% CO_2, light of the lamp reduces by about 25 to 30%.

NO_x – Nitrous fumes are detected by their reddish brown colour and suffocating/choking smell. Smell can be had even at 1 ppm.

– A piece of paper soaked in starch and potassium iodide solution turns bluish in presence of nitrous fumes.

– NO_x can be detected by Auer or Draeger multigas detector also.

H_2S – Detected by its strong pungent smell of rotten eggs or onions; smell is obtained even at 1 ppm. Dangerous percentages destroy the sense of smell soon.

– White blotting paper soaked in a solution of lead acetate turns brown or black in presence of H_2S. Silver coin turns black.

– H_2S can be detected by multigas detector or by Oxymeter/Toximeter also.

SO_2 – It can be tested by Draeger multigas detector using appropriate glass tube. On passing air containing SO_2, the bluish chemical substance in the tube turns colourless.

Any of the above gases can be detected by drawing an air sample and analysing in a chemical laboratory or on a gas chromatograph.

Q. 2. Under what circumstances is CO found in underground coal mines? (1985, 2000)

Occurrence of CO

In u.g. coal mines, CO is found under the following circumstances :

1. Spontaneous heating of coal or fire in mine workings, or in the goaf.

2. In a sealed-off fire area until the fire is extinguished.
3. Near a leaky fire stopping (a very common cause in Indian mines).
4. Blasting.
5. When water is applied to the base of incandescent coal during fire fighting, CO is generated as a component of water gas.
6. After an explosion, it is found throughout the mine. Large quantity of CO is found if coal dust has taken part in the explosion.
7. Exhaust air of diesel engine or compressor.

Q. 3. Describe the effect of carbon monoxide on human body. (1985)

or

Write a short note on : CO poisoning. (2002, 2003)

CO Poisoning

1. Carbon monoxide is the most dangerous gas encountered in coal mines.
2. It is extremely poisonous. Its poisonous effect is due to its great affinity to combine with haemoglobin of the blood to form a fairly stable compound carboxy-haemoglobin. The power of CO to combine with haemoglobin is almost 250 times than that of oxygen. Once the haemoglobin combines with CO, it cannot combine with oxygen, thus oxygen carrying capacity of the blood is reduced. Since oxygen does not reach various organs of the body in sufficient quantity, adverse effects are progressively produced as follows :
   (a) vertigo, headache,
   (b) severe headache, vomiting, possibility of unconsciousness,
   (c) staggering of legs, loss of judgement, more possibility of unconsciousness,
   (d) coma, convulsions, stoppage of respiration, death.
3. A characteristic feature of CO poisoning different from poisoning by other gases is that the victim appears healthy and pink. This is because of cherry red colour of carboxy-haemoglobin build up.

4. CO poisoning is cumulative. A person can be exposed for a number of short durations with no apparent ill effect. However, since each time the blood has absorbed some gas, the victim becomes more and more susceptible to its effect. Thus, in an emergency situation mine officials and workers may be affected by very short exposure of CO if they had earlier exposures to the gas without sufficient time in fresh air to rid their bodies of the effects of carboxy haemoglobin build up.
5. Apart from concentration of CO and time of exposure, poisoning also depends on the state of activity of the person and his mental state.
6. CO is called 'silent killer' because the victim does not recognize the danger until it is too late.
7. A person affected by CO poisoning is to be brought in fresh air, kept warm and administered pure oxygen for a long time. He must be carried on a stretcher.
8. CO has caused many deaths in coal mines. In 1994, 55 persons died in New Kenda colliery due to CO poisoning following a fire in the intake airway. Large number of persons died due to CO poisoning in Bhatdih and Anjan Hill explosious also. In certain situations, life can be saved by using self rescuers.
9. Threshold value of CO is 50 ppm.

Note : Effect of CO in different concentrations is as follows :

CO ppm	*effect on a working man*
50	safe limit
200	tension in forehead, throbbing headache in 2 hours
400	in 45 minutes headache, possibility of collapse
1200	in 30 minutes, severe headache, staggering of legs, mental confusion, unconsciousness.
2000	in 10 minutes coma, convulsions, mental confusion, unconsciousness.
5000	in 1 minute stoppage of respiration and death.
PPM	stands for 'parts per million'.

1 ppm = 0.0001%

10 ppm = 0.001%

100 ppm = 0.01%
200 ppm = 0.02%
500 ppm = 0.05%
1000 ppm = 0.10%
10,000 ppm = 1%
1% = 10,000 ppm
10% = 100,000 ppm

Q. 4. Why are birds used for detecting CO?
What are the guiding principles for using *lal munias* to detect CO?

Use of birds to detect CO

Birds *lal munias* provide a simple method for detection of CO in mine atmospheres. They are affected more quickly by the gas than a human being because they breath about 20 times faster (their volume of respiration in proportion to their blood is much higher than that for men). By their activity, birds give a warning signal without a constant effort. If birds are carried in a cage during inspection, the only thing the man has to do is to keep a watch. By their activity in case of distress, birds easily draw attention. Checks by detector can be done frequently, but they do not provide a constant indication.

However, entire reliance cannot be placed on birds because at lower concentrations (< 0.10% or 1000 ppm), men are affected earlier than birds.

Guiding principles of detecting CO by lal munias

1. Two or three birds should be carried, because birds vary in their sensitivity.
2. On every occasion fresh birds should be used, because they may develop tolerance for small percentages and exhibit no signs of distress.
3. In the cage, there should be two perches, and the birds should be made to go from one to the other frequently. This will increase their rate of breathing and they will give indication earlier.
4. Since at lower concentrations birds are not affected earlier than men, hence on getting slightest indication from birds, men must immediately withdraw to fresh air.

5. Birds do not test for deficiency of oxygen as they can live in a lower percentage of oxygen than is required by men. Hence a flame sefety lamp must also be carried.
6. Birds should not be taken into an atmosphere known to be containing CO.

Q. 5. State the characteristic properties of the following gases : Carbon dioxide, carbon monoxide, nitrous fumes, hydrogen sulphide, sulphur dioxide, methane.

Characteristic properties of gases

Carbon dioxide (CO_2) sp. gr. 1.52 Threshold limit 0.5%

— extinguishes burning materials

— extremely soluble in water

— being 1.5 times heavier than air it is found near the floor and fills in dip galleries.

— colourless, odourless

— produced by burning of coal and carbonaceous material.

Carbon monoxide (CO) sp. gr. 0.97 Threshold limit 50 ppm

— deadly poisonous, has caused maximum deaths in coal mines.

— formed by spontaneous heating of coal, mine fires, methane and coal dust explosions. Small quantities are formed by oxidation of coal at normal temperatures, also by blasting and diesel equipment.

— colourless, odourless

— slightly lighter than air; mixes with air easily.

— not soluble in water

— burns in air with a light blue flame

— 12 to 74% of CO in air renders the mixture explosive, but it is generally not found in such high percentage in coal mines.

Nitrous fumes (NO_x) sp.gr.1.59 Threshold limit 5 ppm

— a mixture of various oxides of nitrogen (NO, NO_2, N_2O_4, N_2O_3)

— yellow to reddish brown in colour

— biting choking smell—a smell of blasting powder fumes

— highly soluble in water

— 1.5 times heavier than air

— extremely poisonous, its most dangerous part in NO_2; poisonous effect starts 3-4 hours after exposure except in high concentrations.

—formed by blasting of nitro-glycerine explosives; also found in diesel engine exhaust gas.

Hydrogen sulphide (H_2S) sp.gr. 1.17 Threshold limit 7ppm

— highly soluble in water, given off on disturbance in the water.

— more poisonous than CO, but found in very small % in mines

— odour of rotten eggs, colourless

—formed by decay of organic matter and timber in standing water of old workings

Sulphur dioxide (SO_2) sp.gr.2.22 Threshold limit 5ppm

— colourless suffocating gas with strong pungent smell of burning sulphur or rotton eggs.

— highly soluble in water

— acidic taste

— very poisonous

— **heaviest of all mine gases**, 2.22 times heavier than air, tends to **settle in low lying areas**

— formed in u.g. workings from blasting and burning of coal.

Methane (CH_4 firedamp) sp. gr. 0.55 Threshold limit 1.25% **(o.75% in distt. return)**

—most dangerous of inflammable gases found in coal mines; practically, all seams emit more or less methane.

— mixtures with air containing 5 to 14.8% methane are explosive; it has caused many explosions throughout the world. In presence of large amount of fine coaldust in air, even 2% CH_4 - air mixture may be explosive.

— less than 5% methane burns in air with a blue flame—a property used for gas detection by flame safety lamp.

— Gas must be in contact with the heat source for a definite time before ignition takes place; this time interval is called lag on ignition. It varies considerably with temperature of the source; for a 6.5% mixture it is 11 seconds at 700°C but only 0.02 seconds at 1200°C. Permitted explosives, approved exploders, flame safety lamp and FLP enclosures are based on this property.

— being much lighter than air (of almost half weight), it is usually found near the roof, in roof cavities and rise workings.

— **forms a layer near the roof rendering detection difficult**

— **found in coal seam and the surrounding strata.**

— not poisonous, but by diluting the air it reduces oxygen concentration; hence it is asphyxiating

— once mixed with air, it does not separate out.

Note : Threshold limit (or Threshold value) is the maximum allowable concentration for work in mine; concentration exceeding it is harmful to health.

Q. 6. At what percentage of oxygen, does a flame safety lamp get extinguished?

If flame sefety lamp continues to burn at a place below-ground, is the air safe?

Safe oxygen content

For every 1% reduction in oxygen content, the light of flame safety lamp reduces by about 25%. At about 17% oxygen, the flame gets extinguished.

A burning flame safety lamp shows adequacy of oxygen, but the atmosphere will not be safe if CO or other toxic gas in present. It is for this reason that regulations provides that while going for inspection of old workings it is essential to carry flame safety lamp apart from birds or an approved CO detector.

Q. 7. (a) Why accumulation test by flame safety lamp is safer than percentage test?

(b) Why is flame safety lamp raised slowly when testing for methane?

Accumulation test and percentage test

Where there is possibility of high concentration of methane, at first accumulation test is done and then the percentage test. Accumulation test is safer in high methane concentration because during accumulation test, a larger part of the lamp is occupied by combustion products. With a small testing flame, there are chances of flame passing out.

Why safety lamp is raised slowly

While conducting accumulation test or percentage test, safety lamp in raised slowly towards the roof, and on first indication of gas, the lamp is not raised further but drawn out. This is because gas concentration may vary considerably, and it is possible that on raising the lamp further, gas in the lamp explodes, and extinguishes the flame—but the gas may continue burning in the gauzes. If gas detection is possible at lower safer level, why raise the lamp further?

Q. 8. Write a short-note on nitrous fumes.

Nitrous fumes

Nitrous fumes are a mixture of various compounds of nitrogen (NO, NO_2, N_2O_4, N_2O_3)

Properties : Yellow to reddish brown colour; biting choking smell; 1.59 times heavier than air; highly soluble in water; extremely poisonous (Threshold value 5ppm).

Places of occurrence : Blasting face-particularly stone drifts and sinking shaft where nitro-glycerine explosives are used (also in exhaust of diesel engine)

Effect : Initial effects are not more than irritation of eyes, nose, throat, windpipe and choking; these symptoms may disappear soon giving an impression that nothing serious has happened. But damage to lungs may continue, and depending on concentration of gas and period of exposure, the victim may suddenly develop pneumonia like symptoms after a few hours, days or even weeks, and die soon.

Protection :
1. Good ventilation.
2. Not allowing any one to approach the blasted face until the fumes have cleared.
3. Drenching the blasted coal/stone thoroughly before starting to load. Nitrous fumes being heavy settle into the blasted material. They are dissolved by water easily.

Detection : By multigas detector.

Q. 9. What steps should be taken on detecting 1.25% or more of inflammable gas in the mine?

Actions on detecting methane

1. Slowly lower the lamp and take it to fresh air. Do not attempt to brush or waft it out.
2. Inform the superior official.
3. Cut off electric power.
4. Withdraw all persons of the district to intake air.
5. Fence off the place.
6. Overman shall take immediate steps to improve the ventilation and find cause of gas accumulation.
7. No person shall be admitted to the place where gas was detected until the place has been cleared of gas—as confirmed by inspection by a competent person with a flame safety lamp or approved gas detector.
8. At end of the shift, the overman shall write a detailed report in the report book kept under Reg.142, stating the place, percentage of gas, cause, action taken to remove the gas and the condition at end of the shift. The report shall be put up to the manager, after signing it with date and time.

Q. 10. Write a short note on : Coward's diagram. (2002)

Coward's diagram

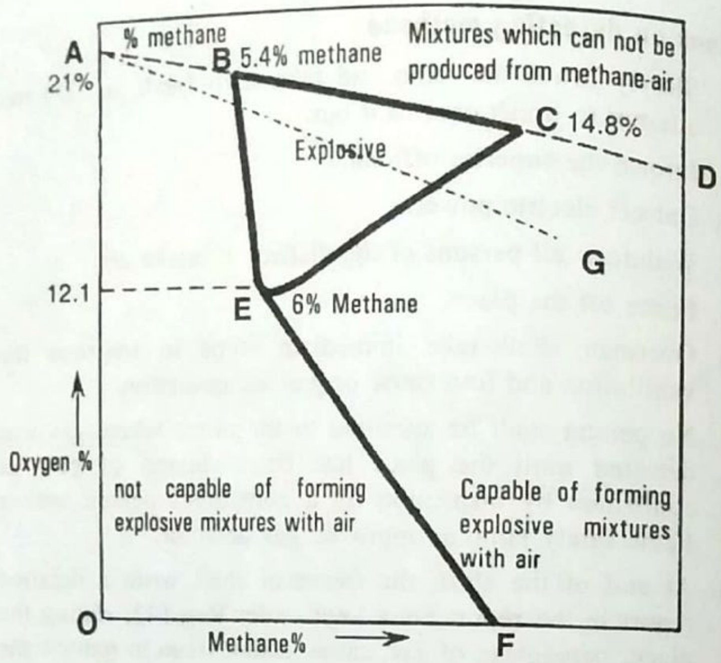
Coward's diagram is a graph which shows whether a methane-air mixture is explosive, or would become explosive on addition of more methane or more oxygen.

In this diagram, vertical lines show % of CH_4 and the horizontal lines the % of O_2. Rest of the atmosphere can be taken as extinctive gases, mainly N_2 and CO_2.

In the diagram, B shows the lower limit and C the upper limit of inflammability of methane in normal air. BE shows the lower limit at different percentages of CH_4, and CE the upper limits.

The diagram indicates the following :

1. All mixtures lying within the triangular area BCE are explosive.
2. All mixtures lying to the right of CEF are non-explosive as they contain too much of methane, but they will form explosive mixtures when mixed with the right amount of air.



3. All mixtures lying to the left of BEF are neither explosive nor capable of forming explosive mixtures with air.
4. Lower limit of explosibility increases only slightly from 5.4% to 6% for all percentages of O_2 down to about 12.1%.
5. The higher limit of explosibility gradually decreases from 14.8% to about 6% with decrease of % of O_2.
6. When O_2 is less than 12%, any % of CH_4 is not explosive.
7. A methane-air mixture may become explosive when diluted with an appropriate quantity of air which beings the new mixture into the triangle BCE.

The diagram is used when sealing off an area on fire or when re-opening a sealed off area.

Q. 11. Write a short-note on methanometer.(1983, 1988, 1993)

Methanometer

Methanometer is a battery operated hand held portable instrument suitable for making spot checks of methane concentration at any place underground, Methanometers of different models are made by various companies.

D-6 methanometer made by MSA company (Mine Safety Appliances Co.) weighing about 470g and capable of measuring 0 to 5% methane is a popular instrument approved by the DGMS. It carries a nickel-cadmium cell which is recharged when the voltage goes down after about 500 tests.

When a mixture of methane-air is drawn into the instrument, it comes in contact with a catalytic element. A rapid combustion of gas takes place which raises the temperature and resistance of one leg of a wheatstone bridge, throwing the bridge out of electrical balance. The imbalance is indicated by the needle as percentage of methane.

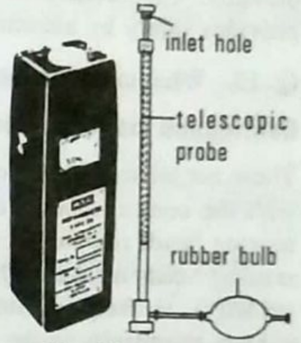


Fig : **Methanometer**

For measurement of methane % at any place, the inlet cap is opened, and pressing methane-check button the methanometer is taken to that place. The needle shows the gas% instantly.

It is provided with a telescopic probe for detection of gas in inaccessible places (roof cavities and high places).

The instrument is sent to CIMFR, Dhanbad every 3 months for re-calibration.

Note : By convention, methanometer means a portable hand-held battery-operated apparatus. Bulkier instruments for measuring methane are called automatic firedamp detectors, methane monitors etc.

Q. 12. What is local methane detector? Where is it used?

Local methane detector (LMD)

LMD is a gas detector designed to continuously measure CH_4 concentrations in the range of 0-3% automatically. It is hung near the face or at a strategic place. When CH_4 exceeds the preset value, it gives an audio-visual alarm—a buzzer and a flashing light, and being electrically interlocked, it cuts off power supply to the district.

DGMS has directed to provide LMDs in degree II & III gassy seams at the following places :

1. Continuous miner face/district
2. On return side of longwall face

3. In return airway in which electric motors run
4. In main return airway of the mine

With change in face operation (cutting, drilling, blasting), variation in quantity of intake air of the district and change in barometric pressure, CH_4 concentration in air keeps on changing. LMD provides safety by automatic detection and warning.

Q. 13. What is continuous methane monitor?

Continuous methane monitor

These are telemetring type automatic gas measuring installations with the control module usually located on the surface and the sensing heads remotely located in various parts of the mine. The sensing heads measure CH_4, CO (and in some cases also O_2, air velocity) at frequent intervals (say every 15 seconds) and convey the results to the control module. A warning lamp and alarm are activated when pre-determined concentration levels are reached at the sensing head.

The 7th Conference on Safety in Mines (1988) recommended installation of continuous monitoring systems for CH_4 and CO in all degree III gassy coal mines and in other mines having active u.g. fire. 8th and 9th conferenes also emphasised on this point. Continuous environmental monitoring systems have been installed in a few mines.

Q. 14. Name some popular multi gas detectors. Describe the functioning of Draeger multigas detector.

Multi gas detectors

Multigas detectors commonly used in Indian mines are those made by MSA, Auer and Draeger companies.

Draeger multigas detector

This instrument is used to measure CO, CO_2, H_2S, SO_2 and NO_2 (but not CH_4 and O_2 due to inaccuracy). It consists of a spring loaded rubber bellows type pump and a range of replaceable glass indicating tubes each with a chemical for the specific gas. The 100 cc pump can be operated by one hand. Sample is drawn through the indicating tube before passing to the bellows.

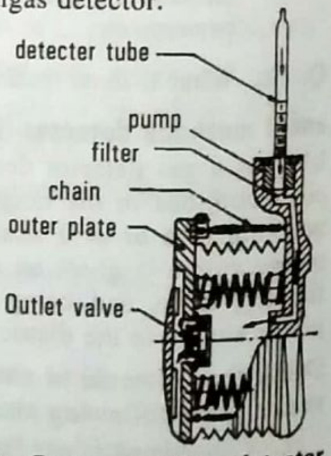


Fig : Draeger multigas detector

Operation

- Squeeze the bellows once or twice to be sure that the outlet valve is operating.
- Select tube suitable for the gas to be checked, see its expiry date; break the sealed ends and fit it in the inlet of the bellows with its arrow pointing to the direction of flow.
- Squeeze the bellows and leave it. It will be completely filled in about 45 seconds.
- Read the ppm against the discolouration on the tube.
- Write time, date and place on the writing end of the tube.
- If there is no discolouration, it means there is no gas. The tube can be re-used upto 10 times.

Q. 15. Write a short note on Oxymeter/Toximeter.

Oxymeter/Toximeter

Oxymeter/Toximeter model PAC-III is a portable hand held gas detecter (weighing only 185g) manufactured by Draeger company measuring CO, O_2 and H_2S concentrations. It has several electrochemical cells—each for a particular gas. The respective electrochemical sensor is plugged into the device and it is ready for use. It has adjustable audio-visual alarm. It operates with nickel-cadmium battery. The illuminated display can be seen in the dark also. Apart from gas%, it has several displays regarding battery O.K., sensor O.K., next date of calibration etc. Range of sensors : carbon monoxide 0-2000 ppm, oxygen 0-25%. Sensors for other toxic gases are also available.

Fig : PAC-III

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Chapter 16

FIREDAMP EXPLOSIONS

Q. 1. (a) Explain classification of coal seams according to gassiness.

(b) If the same coal seam is being worked in two adjacent mines, will their gas-degree be the same?

Classification of coal seams according to gassiness

1. In the process of coalification (i.e. conversion of plant debris into coal) inflammable gas methane was produced in large quantity (over 500 m^3 per tonne of coal). In course of time, a large part of the gas has escaped into the atmosphere, but some gas has remained pent up in pore spaces of coal, and in cracks/crevices/bedding planes of coal seams and the surrounding strata. Hence every coal seam is considered gassy.
2. The DGMS has classified all coal seams (mine-wise) into 3 degrees of gassiness, on the basis of gas concentration in the general body of air in u.g. workings within the mine boundary and the rate of emission of gas per tonne of coal produced as follows :

Degree	% of inflammable gas in general body of air	Emission of gas per t of coal produced
I	less than 0.1	less than 1 m^3
II	more than 0.1	1 to 10 m^3
III		over 10 m^3

3. In every mine gas survey is done every month. If gas degree is found to be higher, immediately precautions required for the higher degree are taken and information is sent to the Regional Inspector.

   Similarly, if gas degree is found by the management to be lower, information is sent to the Regional Inspector for verification and confirmation. But until the confirmation is received, precautions as before are continued.

Gas degree of a seam in adjacent mines

Gas degree of the same seam worked in two adjacent mines may or may not be the same. For each mine, gas degree is fixed separately after gas survey in its workings.

Q. 2. (a) What are the modes of emission of firedamp in the mine?

(b) What is a blower? What actions will you take on meeting a blower?

Modes of emission of firedamp

Firedamp or methane entrenched in coal seam and the adjacent strata is given off in 3 ways :

1. **Slow emission** from pores and invisible cracks in the coal or adjacent strata through their exposed surfaces. This is a continuous and prolonged emission.
2. In the form of **blowers** from visible cracks and openings in the coal or rock. These are generally short lived, but sometimes continue for years. Blowers are common is Indian mines. A blower in Moonidih (1971) lasted for 2 years and gave off about 4 million m^3 of gas.
3. **Sudden outbursts** of firedamp, generally accompanied by ejection of large quantities of coal or rock. Outbursts are not common in Indian mines. There has been only one case so far.
4. Methane accumulated in the goaf area may erupt into the workings when there is sudden fall of barometric pressure or major roof fall in the goaf.

Blowers

1. Blowers are jets of gas from cracks, usually accompanied by a hissing sound and, if the gas comes from beneath water, also by loud bubbling sound. Many blowers at first throw water and then gas.
2. Blowers are mostly found in places which have been folded or faulted.
3. They may last only a few days, but in some cases even for some years.

4. Discharge of gas is maximum in the beginning and it reduces gradually until the gas is exhausted.
5. Blowers are extremely dangerous, because they are met unexpectedly, and may affect not only the individual gallery but even the whole district, filling it with mixtures of gas and air which may be suffocating as well as inflammable.

Actions an meeting a blower

1. Men shall be withdrawn from the gallery and it shall be fenced.
2. No person shall be allowed to be on its return side.
3. Power to the district shall be cut off, but auxiliary fans shall continue to run.
4. Blasting work in the district shall be stopped.
5. Air into the gallery shall be increased by re-arranging ventilation. Coursing barricade/auxiliary fan tubing shall be extended upto the blower.
6. Manager shall be intimated.
7. If gas emission continues, a 30-40cm deep trench shall be cut around the blower and a pipe shall be fixed by brickwork. The pipe shall be extended upto the return airway and its mouth placed in a drum filled with sand. Gas will be slowly discharged into the return air.
8. Gas checks shall be made at all faces. Normal work shall be resumed only after an official has confirmed all faces to be free from gas.
9. Report of occurrence of gas with date, time, place, concentration of gas and steps taken shall be recorded in a bound-paged book kept under Reg. 142.

Q. 3 What precautions will you take:
On detecting inflammable gas in a development gallery? (2010, 2014)

Actions on detecting inflammable gas

1. Men shall be withdrawn from the gallery, power shall be cut off and gallery shall be fenced.
2. Steps will be taken to remove the accumulation by increasing quantity of air, extending the coursing/barricade/auxiliary fan tubing etc.
3. During the removal of such gas, all persons from the return side of the face shall be withdrawn, power cut off, and blasting work shall be stopped.
4. Normal work shall not be resumed without a thorough check and being sure that accumulation has been fully removed.
5. Particulars of the occurrence shall be recorded in a BP book kept under Reg. 142 mentioning:
    - Name of the face
    - % of inflammable gas found
    - Date, time of detecting the accumulation
    - Action taken
    - Date, time when it was removed.

The record shall be put up to the manager for counter-signature.

If no gas was detected in the mine anytime earlier, on detecting gas accumulation, information shall be sent to the manager immediately.

Q. 4. What is 'standard of ventilation'? What precautions are required to be taken during development in gassy mines? What action will you take on detecting inflammable gas in a development gallery? (2014)

[**Note :** Standard of ventilation has been explained in Q. 1 in chapter on Ventilation. Actions on detecting inflammable gas have been given in Q. 3 above. However this question is answered here to illustrate the need of compressing essential information when a large question is asked. Read those two questions and then this one.]

Standard of ventilation

- **Quantity** in last ventilation connection – minimum 6 m^3/minute per person in the district in the largest shift, or 2.5 m^3/minute per t of daily production (whichever is more).
- **Quality :** At any place where persons work or pass- O_2 not less than 19%, CO_2 not more than 0.5%, no noxious gas likely to affect the health, CH_4 not more than 1.25% at any 0.75% in district return & not more than 0.3 mg/m^3 of air. place. Respirable dust not more than

- **Wet bulb temperature:** not more than 33.5° C; if more than 30.5°C, air velocity not less than 1 m/sec.

Precautions against gas during development

- Mining sirdar shall inspect all roadways & working places for ventilation and gas within first 2 hours of the shift, before engaging men, and then every 4 hours.
- Air shall be coursed to 4.5 m of the face.
- No charging or blasting if inflammable gas is detected at any hole or within 18 m of it; no charging/firing on its return side.

Actions when gas is detected at any place

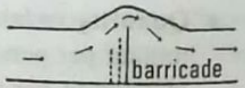
- Withdraw all persons from the place, cut off power & fence the gallery.
- Overman to improve ventilation to dilute gas. During removal of gas, withdraw all persons from the return side, cut off power, stop charging/blasting.
- Normal work not to be resumed until gas has been removed, place checked & declared safe.

Q. 5. How will you clear firedamp accumulated in a roof cavity? What measures would you adopt to prevent gas accumulation there in future?

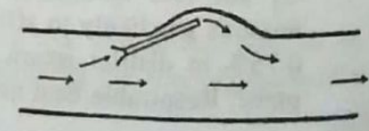
Removal of gas from roof cavity

Gas accumulated in a roof cavity can be removed by one of the following methods :

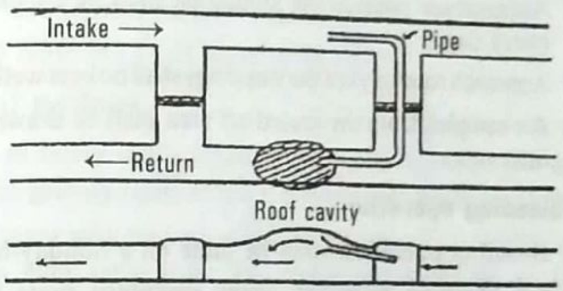
1. Erect a barricade of half the gallery height across the roadway and on intake side of the roof cavity to deflect the air into the cavity. Increase the barricade height progressively until all gas is cleared.



2. Using props or hooks fixed in the roof, set a short length of about 30cm dia pipe with its one end facing the intake air and the other end reaching the cavity. Air reaching the cavity will dilute and remove the gas.



3. If cavity is in a return airway, fix a 25-30cm pipe facing the intake air in a nearby intake airway, add lengths of pipes upto the roof cavity. This will send some intake air into the cavity and clear the gas.



4. If cavity is in a return airway and another return airway is passing nearby, close the second return airway by erecting a temporary brattice stopping to divert all the air to the affected return roadway. Increased quantity and velocity of air will remove the gas.

Permanent measure

After removing gas accumulation by one of the above 4 methods, fix girders across the gallery at roof height below the roof cavity, place cgi sheets on the girders and then put sand bags/stonedust bags over the cgi sheets to fill up the cavity.

Q. 6. In an underground coal mine, a sealed off area of old workings is causing problem by emitting firedamp in large quantities during fall of barometric pressure. How will you manage the situation? (1998)

Bleeding the gas from isolated old workings

Leakage of large quantities of firedamp from the sealed off area of old workings indicates that (1) the area contains a high concentration of firedamp, (2) stoppings are leaking heavily.

DGMS has advised to keep a careful watch on sealed off areas by drawing air samples regularly. When air samples show CH_4 2% or more, behind the rise most stopping—

- isolation stoppings shall be strengthened to make them explosion proof, or
- the sealed area shall be degassed.

We shall follow the easier method of the two :

(a) Gas shall be bled off from the isolated workings.

(b) Isolation stoppings shall be checked thoroughly and repaired.

(c) Atmosphere outside the stoppings shall be checked for gas every day.

(d) Approach roadways of the stoppings shall be kept well ventilated.

(e) Air samples from the sealed off area shall be drawn at weekly intervals.

Gas bleeding operation

1. Bleeding operation shall be done on a Sunday/holiday.
2. For bleeding purposes, some stoppings must have been provided with large dia pipes. The flange of the return side pipe will be opened first and the intake side later. Fresh air will enter the sealed off area and come out through the return carrying firedamp with it. At the return side pipe, and in the return airway, gas concentration shall be checked at hourly intervals. Entry of air into the area shall be regulated as required.
3. By erecting temporary stoppings, the area opened shall be ventilated stage by stage.
4. Work may prolong for more than one shift.
5. After the area has been cleared of gas, the broken stoppings shall be repaired, leakage points shall be sealed and the pipe flanges closed.

Precautions

1. Workings on either side of the return airway shall be fenced. On the return side, electric power shall be kept switched off. Roadway will be stone dusted.
2. An area upto 30m from the fan drift shall be cordoned off and no person shall be allowed to smoke there.
3. Only minimum number of persons required for the operation shall be engaged. An eye shall be kept on their movement.
4. After completion of the work, area outside each stopping shall be checked for gas.
5. Entire operation shall be planned in advance, and carried out under personal supervision of Asstt. Manager and Overman. A record of work shall be kept in the report book kept under Reg.142(6)

Q. 7. (a) Explain what is layering of methane. What dangers are associated with roof layers?

(b) How can a gas layer be removed?

Layering of methane

Formation of fairly stable layers of methane at roof level, due to low specific gravity (only 0.553), is known as methane layering.

- The layer may be only a few centimetre thick, and in some cases even only 1cm; thus a few cm from the roof, gas content may be nil but at the roof level it may be even 40-50%—in between there may be a portion within the range of inflammability.
- The layer is only a few metres in length.
- It has a tendency to move along the roof towards the rise. It may travel considerable distance from the place of its formation.
- The gas may be emanating from cracks/crevices in the roof.

Methane layers have been detected in many development districts and even in some drifts in Indian mines.

Dangers of layering

1. Layers are difficult to detect, and may remain undetected.
2. A layer may lead to accumulation of gas in unexpected places.
3. In the event of an iginition, the explosion can be transmitted to a considerable distance, involving a number of gas accumulations.
4. In many cases, persons have been asphyxiated by putting their head into the roof cavity (which is deficient in O_2), and fallen from a height resulting to fatal injuries.
5. A roof fall may push accumulated gas to the floor level. If it simultaneously damages a cable, passing below the cavity, explosion can occur. Such explosions have occurred in Indian mines.

Removal of gas layer

1. A gas layer may be removed by erecting one or more

hurdles at the floor level across the roadway to increase velocity of air at roof level.

2. If compressed air is available, a jet of compressed air may be directed into the gas layer to produce movement and remove the gas.

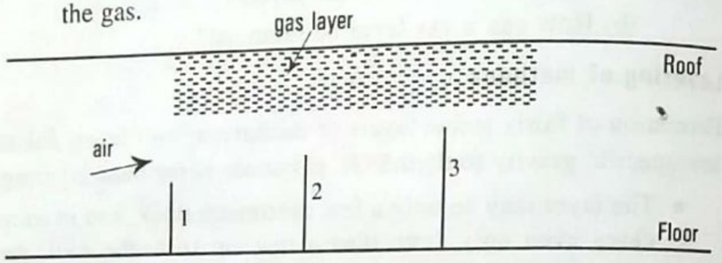


Fig : **clearing gas layer**

Q. 8. What do you understand by limits of inflammability of methane?

What is the danger associated with gas concentration outside these limits?

Limits of inflammability

When methane comes is contact with a heat source of sufficient intensity, it burns. But when a methane-air mixture contains 5.4 to 14.8% methane, it explodes, that is, once ignited, the flame propagates throughout the mixture independently and away from the source of ignition, at high speed and with violence.

When methane content is less than 5.4%, it does not explode because the mixture is too thin and the heat produced is not adequate. This is known as 'Lower limit of inflammability'. Above 14.8% methane, it does not explode because the mixture is too 'rich' in fuel, and oxygen present is not adequate to permit rapid propagation of the flame. 14.8% in known as the upper limit of inflammability of methane.

Danger outside the limits of inflammability

1. A methane-air mixture containing less than 5.4% methane may explode when the source temperature is very high.
2. When the mixture in a crack is adiabatically compressed during blasting in a hole, a 2% methane-air mixture may also explode. (under adiabatic compression the upper limit increases from 14.8 to 74%).

3. Presence of other inflammable gases like ethane, hydrogen and CO, reduces the lower limit.
4. In presence of fine coal dust, the lower limit of inflammability may reduce from 5.4% to as low as 0% (In presence of $5g/m^3$. fine coal dust, a 3% methane-air mixture may explode; in presence of $10g/m^3$ coal dust, a 2% methane-air mixture may also explode).
5. There is danger when methane content is over 14.8%, because the mixture can get diluted on addition of fresh air and come within the range of inflammability.

Q. 9. The lower limit of inflammability of methane is 5.4%. why then the regulations require precautions to be taken when the gas exceeds 1.25% only?

Regulations require that when at any working place, 1.25% or more methane is detected, men shall be withdrawn to intake air and the power shall be cut off. This is at much below the lower limit of inflammability 5.4%. Such a high margin is necessary for the following reasons :

1. Checks for methane are not done continuously but only at intervals. A cushion is necessary against unexpected and sudden large emissions of gas, or changes in methane concentration with change in face operation (cutting, drilling, blasting) or variation in quantity of intake air in the district.
2. Presence of methane is checked only at a few places. Gas build up at other places may go undetected.
3. In case of a sudden fall in barometric pressure or heavy roof falls in the goaf, a large quantity of goaf gases may erupt into the workings.

Q. 10. Describe the precautions to prevent occurrence of firedamp explosion in a mine.

Precautions against firedamp explosion

Firedamp explosion can be prevented by :

1. Avoiding accumulations of firedamp
2. Avoiding sources of ignition.

Measures to prevent accumulations of firedamp

(a) Proper ventilation :

- Every part of the mine should be properly ventilated with air at good velocity. Gas at any place should not be more than 1.25% and in the district return not more than 0.75%. Old workings should be kept isolated by stoppings.

- Air velocity should be sufficient to prevent gas layering.
- Fan should run continuously. All air control devices (stoppings, doors, air crossings) should be maintained as leakproof as possible. If any stopping is broken for passing pipes/cables, it shall be closed soon. Pucca stoppings should be kept extended, ventilation doors should not be left open. If any door is required to be opened frequently, a man should be posted there.

(b) Attention to places of occurrence :

- Air should be coursed upto 4.5m of the faces. Advance gallery (*mool*) should not be more than 3m ahead of the widened gallery.
- **Blind ends** should be joined or packed solid with stone and faced with a stopping.
- **Roof cavities** should be avoided by attention to drilling and blasting. Small cavities should be supported to prevent them from becoming big. Bigger ones should be packed solid, and until this is done, they should be kept ventilated.
- **Closed rise galleries** should be kept free of gas by coursing the air.
- **Near faults and dykes** special attention should be paid to ventilation because more gas may be found there.
- On meeting a **gas blower**, quantity of air should be increased to dilute the gas, or the firedamp should be led by a pipe direct to the return.

  Auxiliary fans should be so installed and operated as not to re-circulate the air.

(c) Inspections for gas

- Checks for gas should be done carefully. Methanometers or top feed safety lamps should be used to detect gas layers. Goaf edges and places near faults should be checked for gas frequently, specially when the barometer is falling.

- In deg. I mine also, checks for firedamp should be done meticulously (Sawang and Dhori collieries were considered non-gassy, but suddenly large quantities of firedamp were given out leading to explosions).
- LMDs should be installed at specified places in degreeII and III gassy seams to automatically and continuously detect % of CH_4. These should be interlinked with power system to cut off district power supply whenever CH_4 increases to 1.25%.
- Methanometers should be kept well maintained, and calibrated regularly.
- In deg. III mines, continuous methane monitoring systems should be installed.
- Mining sirdars and overmen should be given refresher training in gas testing.
- Inspection for gas at working faces should be carried out on holidays also.

Measures against sources of ignition

1. If at any place gas is found in excess of 1.25%, men should be withdrawn, power cut off, blasting stopped and steps taken to improve ventilation.
2. As soon as the main fan stops, power to the district should be cut off.
3. It should be ensured that body searchers carry out checks for contrabands properly.
4. Safety lamps should be maintained well. A lamp with broken glass or damaged wire gauze can be a source of fire.
5. Blast holes should be checked for cracks before charging the explosive. Blown out shot should be prevented by correct pattern of holes, adequate stemming, avoiding overcharging. Only approved cables, exploders, testers and explosives should be used.
6. Where required as per law, only approved FLP or intrinsically safe equipment should be used. Electrical apparatus should be kept well maintained. Armoured cables should be kept supported, they should not be overloaded. Trailing cables should be protected from

damage. At end of the shift, power of CCM, drill, SDL, LHD etc. should be cut off. While repairing electrical apparatus, care should be taken to avoid open sparking.

7. To prevent frictional sparks, friction rollers of haulage, and rollers and idlers of belt conveyors should be cleaned, oiled/greased regularly; belt should not be allowed to rub against wooden supports. In fluid couplings and hydraulic supports etc. only fire resistant fluid should be used.
8. Picks of coal cutters and shearers should be sharp, of correct design and in complete sets. No cutting should be done until the wetting arrangement is working efficiently.

From time to time risk assessment should be done to review the danger and adequacy of precautions taken. Constant vigilance is a must.

Q. 11. What conditions can be anticipated following an explosion in the mine?

Likely conditions in the mine after explosion

1. Presence of CO, CO_2; depletion of oxygen.
2. Presence of airborne dust and smoke. Poor visibility.
3. Broken stoppings, derranged ventilation.
4. Fires or imminent danger of fire.
5. Roof falls and debris in the roadway.
6. Dislodged roof supports increasing the danger of falls.
7. Possibility of further explosions.

Q. 12. What are the main characteristics of a firedamp explosion which differentiate it from coal-dust explosion?

What is meant by 'backlash'?

Characteristics of firedamp explosion

1. A firedamp explosion is limited in extent and usually confined to the face area and return airways because firedamp accumulations are likely to be found in these places only.
2. The explosion is usually confined to one ventilating district because it is unlikely that there will be firedamp accumulations in two districts simultaneously. Coal dust explosion traverses almost the whole mine and the main intake roadways are most affected because they are haulage roadways and contain dust.
3. Firedamp explosion is less violent than a coal dust explosion.
4. Firedamp explosion is always accompanied by two shocks– the forward shock and the 'backlash'.

Backlash

Firedamp explosion is accompanied by two shock waves : (a) the forward shock wave caused by heated gaseous products under high pressure, travelling away from the point of explosion rapidly with great force, (b) the reverse wave or 'backlash' which results from pressure drop at the point of explosion due to cooling of gases and condensation of water vapour (which occupy much less volume). Backlash is less forceful but it follows the path just traversed by the forward wave.

Coal dust explosion is a single violent detonation.

Q. 13. While present u.g., you hear a loud sound as that of an explosion. Assuming that an explosion has occurred, what steps will you take for safety of your workers?

Actions of overman following an explosion u.g.

Exact procedure will depend upon the situation, including distance of the place where explosion has occurred, layout of the mine, ventilation system, distance of the district from mine outlets, availability of telephone etc. In such a situation generally telephonic communication is disrupted and no guidance from manager may be available.

Many times, a gas explosion is followed by a second one. Keeping all these things in mind, actions may be some what on the following lines :

1. Collect all workers by sending a word, count with help of mining sirdar, make sure that no person is missing or left behind.
2. Tell them what had happened. Re-assure them and decide to escape via intake airway and downcast shaft. Mining sirdar will bring up the rear.

3. If on the way, there are sign of violence (like jumbled up track, tubs, roof falls, smoke coming), take an alternative route avoiding the return airway that would be fouled by smoke and toxic gases.

4. If the district is on return side of the explosion, smoke and foul gases would be entering the district. In that case workmen will be asked to put on their self-rescuers and escape via the return.

   If the return side is also affected by afterdamp and roof falls, the only course will be to retreat inbye and conserve the air which is still unpolluted.

In that case :

- shall erect a barricade by brattice, c.g.i sheets, conveyor belting, PVC sheet etc. (whatever is available) to prevent smoke and gases to enter the unpolluted zone.
- air outside the barricade will be short circuited to the return.
- marks shall be left on ventilation door, pipes, rails etc. outside the barricade, so that the rescue team comes to know of the place where workmen all holed up.
- shall try to conserve air inside the barricade. From time to time one person shall move a bit inside to produce movement in the air.
- shall try to conserve water and lights. Only one caplamp shall be kept on at a time; flame of safety lamp shall be lowered.
- shall wait for rescue team to arrive; from time to time shall pound pipe line, track rails, roof etc, by pick, stone, hammer, sabbal etc. to signal presence to the rescue team.

●

Chapter 17

INUNDATION OF MINE WORKINGS

Q. 1. (a) What are the underground sources of inundation of mine workings?

(b) Describe briefly the precautions to be taken to guard against inundation from these sources. (1981, 1997)

u.g. sources of inundation

1. Water-logged old workings, goaf or sump (in the same seam or in adjacent seam)—
   - (a) overlying seam or section,
   - (b) lower seam or lower section—at a place which is at higher level than the present workings,
   - (c) any other upper seam—if a fault passing through it is passing through the present workings also,
   - (d) in the same district or in adjacent district.
2. Water bearing strata in roof of the seam being worked.

Precautions

1. From time-to-time, and particularly before rainy season, the water danger plan shall be updated; sources of danger and precautionary measures shall be reviewed and inspected. Corrective actions shall be taken.
2. If work is to be done at any of the following places, all details of position, extent and depth of workings shall be obtained and recorded, and a scheme of working shall be made and implemented to prevent inundation of mine workings :
   - (a) any place underlying another seam or section,
   - (b) any place which is at a lower level than any other place in lower seam or section,

(c) any place approaching a fault thorough an upper seam or section which contains or may contain an accumulation of water or other liquid matter (slurry or other material that can flow when wet)

(d) water bearing strata.

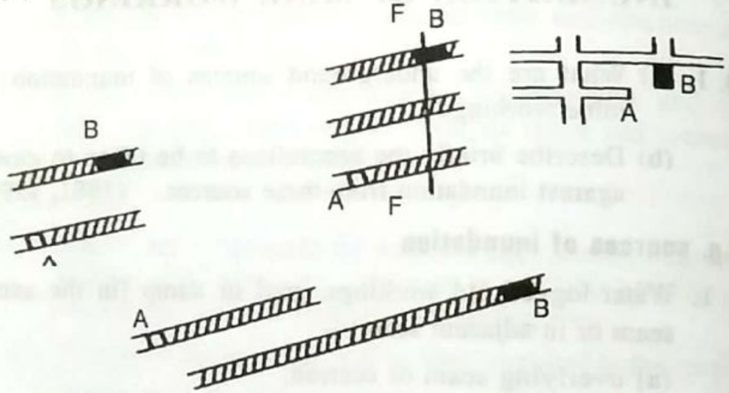


Fig : **A-face, B-waterlogged working**

3. Before extending workings within 60m (in any direction) of any working which contains or might be containing water, permission shall be taken from the Regional Inspector, and work shall be done following the precautions stipulated by him.

4. Whenever seepage of water which is not normal to the seam is noticed in any place in any working, or if there is any such suspicion or doubt—
   - the working shall immediately be stopped,
   - Chief Inspector and Regional Inspector shall be informed forthwith,
   - workings shall not be extended further without written approval of Chief Inspector subject to conditions specified by him.

Q. 2. Write statutory provisions about :
Danger from underground inundation. (2008)

Danger from underground inundation

1. In every mine, **proper provision shall be made** :

a. To prevent eruption of water (or other liquid matter or any other material likely to flow when wet) from the workings of the same mine or an adjoining mine.

b. To prevent accidents while drilling boreholes for probe or release of a body of water or other liquid matter.

2. Before commencing extraction in any of the places mentioned below,

a. All useful information including position, extent and depth of features, shall be acquired and kept recorded,

b. A scheme of working to prevent eruption shall be prepared and put into operation.

Places :

a. Any seam or section below another seam or section.

b. Any place in a seam or section which is at a lower level than any other place in a lower seam or section.

c. Any place in a seam approaching a fault through an upper seam or section which contains or may contain an accumulation of water (or other liquid matter or any material that is likely to flow).

d. Any water bearing strata.

3. Also, prior written permission from the **Regional Inspector** shall be obtained for extending further, any working which has approached within **60m** of any other working in the same mine or in an adjoining mine.

But, such permission is not required if such other working has been physically examined and found to be free from accumulation of water (or other liquid matter or any material that is likely to flow when wet).

Explanation : **60m** as said above means **the shortest distance** between workings of the same seam or between any two seams or sections, measured in any direction—horizontal, vertical or inclined.

4. (a) For getting permission from Regional Inspector as above, the application shall be accompanied by **two copies of the plan and section** showing:

i outlines of all such disused or abandoned workings in relation to the workings approaching them, and

depth of such disused or abandoned workings from the surface.

ii. **outlines, layout and method** of proposed workings.

iii. **faults, dykes & other geological disturbances**.

iv. any **other information** that is **available** with the management, and other particulars or information that maybe **required** by the Chief Inspector.

(b) Working shall be extended strictly in **accordance with approved plan & method**.

There shall be no variation unless the variation is again approved by the **Chief Inspector**.

5. Whenever **seepage** of water, which is not normal to the seam, is **noticed** at any place in any working, or if there is any **suspicion or doubt**:
   - Such working shall be stopped,
   - Chief Inspector & Regional Inspector shall forthwith be informed,
   - Working shall not be extended further without prior written permission of the **Chief Inspector** and subject to such conditions as he may specify therein.

6. (a) **Height or width** of any workings, for which permission has been given by Regional Inspector or Chief Inspector as above, shall not exceed **2.4m**.

&

There shall be maintained atleast one **borehole** near the **centre** of working face, and sufficient **flank** boreholes on each side, where necessary boreholes **above and below** the workings at intervals of not more than **5m**.

- All such boreholes shall be drilled **sufficiently close** to each other to ensure that the advancing face will not accidentally hole through into a working containing water (or other liquid matter or any material that is likely to flow when wet), and ***shall be constantly maintained*** at *sufficient* distance (**not less than 3m**) in advance of the working.
- These precautions shall be carried out under direct **supervision** of an official having manager's or overman's certificate specially authorised for the purpose.

(b) A **record** showing,

exact height and width of such working
number of boreholes driven
length of each borehole
places & direction of each borehole

shall be maintained by the above authorised official in a B.P. book kept for the purpose.

Entries shall be **signed** and dated by the competent person and **countersigned** by the manager **every day**.

Also, a **plan & section** of such workings showing the above particulars shall be prepared and maintained, and brought up-to-date atleast once every **15 days**.

7. Unless Chief Inspector grants specific relaxation in writing, provisions of sub- regulation (6) above shall be strictly complied with.

8. Depending on conditions in the mine, Chief Inspector may **relax, vary or dispense with** all or any of the conditions/ requirements of sub-regulation (6), or he may ask **for additional precautions**.

Q. 3. What precautions shall be taken while advancing development workings u.g. within 60m of water logged workings? (1987, 1993, 2003, 2007, 2011, 2012)

Development within 60m of waterlogged workings

1. **Obtaining information** : When the workings reach within 120m of the water logged workings, a re-survey of the workings shall be done to correlate with the water logged workings. Plans and records shall be studied to obtain maximum information about extent and depth of water logged workings, quantity and pressure of water, nature of strata to be crossed, presence of faults, bore hole, shaft, drift etc, and the information shall be recorded.
2. **Dewatering** : If possible, the water logged workings shall be dewatered, inspected and surveyed–this being the safest course.
3. **Permission** : If dewatering is not possible, a layout of proposed workings, method of work, relevant plans and all

information shall be sent to Regional Inspector to obtain permission.

4. **Scheme of working** : Manager shall make a scheme of working and hand it over along with a copy of approved plan to concerned overmen and assistant managers.
5. **Working** :
   (a) Workings shall be advanced strictly as per the approved layout.

   (b) Height and width of workings (each) shall not exceed 2.4m.

   (c) Atleast one bore shall be maintained hole near the centre of working face and sufficient flank bore holes on each side, where necessary, bore holes above and below, at intervals of not more than 5m.

   All such bore holes shall be drilled sufficiently close to each other to ensure that the advancing face will not accidentally connect to waterlogged workings, and the holes shall be kept constantly advanced to provide a barrier of *atleast* 3m. Bore holes shall be drilled by a safety boring machine.

   (d) If seepage of water not normal to the seam is noticed, workings shall not be advanced further and information shall be sent forthwith to manager, who shall inform Chief Inspector and Regional Inspector. Further actions shall be decided jointly.

   (e) All work shall be done under personal supervision of overman or assistant manager specially authorised for the purpose.

   (f) A record showing exact height and width of such workings, number of bore holes driven, dia and length of each bore hole, places at which and the direction in which each bore hole was driven, shall be maintained by the above official in a bound paged book kept for the purpose. The entries shall be signed by him and counter signed by manager everyday. Also, a plan and section of such workings showing the above particulars shall be prepared and maintained and brought up-to-date atleast once in 15 days.

(g) **Other precautions**

- immediate strong support of roof and sides
- good ventilation upto the face
- frequent checks for CH_4, CO and H_2S
- adequate arrangements for pumping
- use of safety lamp

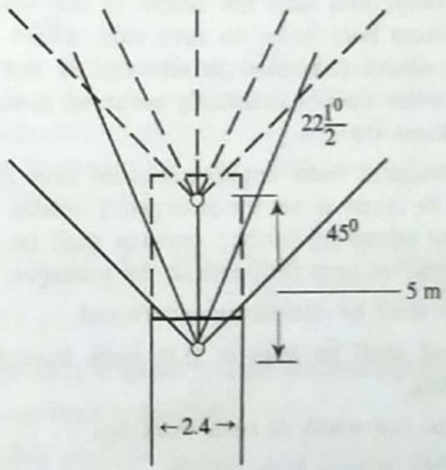


Fig : **Pattern of advance boreholes**
(Pattern will be based on local conditions and approved by the Regional Inspector)

6. **Emergency organisation** :
   - Standing Orders shall be made to inform the workers and to withdraw them.
   - An escape route shall be identified which is free from depressions, has deep drains, and hand rails.
   - Bulk head door shall be fitted for use in emergency.
   - Only experienced staff and workers shall be deployed.

Q. 4. What precautions will you take :
While advancing workings towards water logged workings? (2010)

Precautions by overman while advancing workings towards water logged workings

1. Workings shall be advanced strictly as per the layout approved by the DGMS.

2. Work shall be done as per the stipulations of the DGMS as contained in Manager's Scheme.
3. Height and width of workings shall be as per the Manager's Scheme, but, shall not exceed 2.4m in any case.
4. Advance bore holes shall be drilled as per the approved pattern, using safety boring machine. There shall be atleast one bore hole near the centre of the working face and sufficient bore holes on each side, where necessary bore holes above and below, at intervals of not more than 5m. The holes shall be constantly advanced to maintain a barrier of atleast 3m.
5. If seepage of water not normal to the seam is noticed, action shall be taken as per the emergency orders. Workings shall not be advanced further, persons shall be withdrawn and information sent forthwith to the manager.
6. Work shall be constantly supervised.
7. Record shall be kept in B.P. book kept for the purpose showing,

   Height and width of such workings

   Number of bore holes driven

   Diameter and length of each bore hole

   Places at which bore holes were driven
8. **Other precautions**
   - Prompt and effective support
   - Good ventilation upto the face
   - Frequent checks for CH_4, CO and H_2S
   - Use of safety lamps
   - Readiness of pumping arrangements
   - Inspections of escape route. It shall be free from depressions, and shall have deep drains and handrails.

Q. 5. How a mine can get inundated by workings of the same seam in the same mine?

Inundation from the same seam

Workings may be inundated from the same seam as follows :

- a gallery joining with a water logged dip gallery

- a gallery holing into water logged old workings in the same seam
- failure of weak retaining wall of a sump
- bursting of water dam
- gushing in of water accumulated behind a stopping
- sudden influx of accumulated slurry or sand along with gushing water
- water from the underlying stowed galleries suddenly rushing into the present workings breaking the parting, due to reduction of thickness of parting or presence of a fault (as happened in June, 2003 in Godavari 7LEP mine of **Singareni**).

Q. 6. What precautions will you take in the following case—Driving a level or rise heading to join it with a water logged dip gallery. (1984)

Precautions in joining a gallery with waterlogged gallery

1. Before advancing the working-
   (a) the gallery shall be dried out by installing pumps or siphons,
   (b) muck shall be cleared, and
   (c) the gallery shall be surveyed to know its correct position with respect to the current working.
2. If pumping of water is not possible, then all the precautions under Reg.127 for drivage towards water logged workings within 60m shall have to be taken.

Note : 10 persons were killed in Silewara Colliery of WCL in 1975 because of failure to take the above precautions.

Q. 7. State the causes of inundation of a mine by surface sources.

Surface sources of inundation

- Flowing water—river, canals, *jorè*
- Standing water—ponds, tanks, lakes
- Accumulated water—accumulated water in low lying area, subsidence area and abandoned O/C mine

Causes of inundation

1. Mine entrances (shafts, incline, stowing shaft, air shaft), bore hole (prospecting bore hole, stowing bore hole, pumping bore hole or bore hole for electric cable), fault or subsidence cracks at lower level or not adequately above the HFL of nearby river or *jore*.
2. Development of cracks or pothole in water logged subsidence area.
3. Formation of pothole due to working at shallow depth or in weak strata.
4. Water accumulated in abandoned O/C mine entering into the mine workings, breaking the barrier or stoppings built in u.g. mine entries connected to the opencast. The water may carry with it huge quantities of OB also.
5. Failure of embankment of pond which is at a higher level than the mine entrances, or water overflowing the embankment.
6. Sudden rise in water level of a river due to obstruction in the flow resulting in water entering the mine through incorrectly located mine entrances.
7. Conducting depillaring operations below or near a river, pond or tank.
8. Failure of weak or fire affected pillars below river, *nalla, jore,* pond or tank.
9. Sudden rise in water level of river or *jore* due to release of water from a dam on the upstream side or due to backflow of water from a river on the downstream side due to torrential rainfall.
10. Inaccuracy or incompleteness of mine plan—not showing a *jore* (inundation of Saunda Colliery of CCL in 1976), altered course of river, fault, wrong surface contour, missing boreholes, faults etc.
11. Failure of embankment against a river or pond (inundation of Gaslitand Colliery of BCCL in 1995 due to breach of embankment made against Katri river, and inundation of Umrer opencast (SECL) due to breach of embankment made against Amb river in 2010).

Q. 8. Describe the precautions to be taken to prevent inundation of mine workings from surface sources.

Preventing inundation from surface sources

1. Work underneath source of water

No working shall be made below or within 15m of the boundary of a source of water (river, *jore*, pond, tank). If this is unavoidable, permission from DGMS shall be taken. and the conditions imposed shall be strictly observed. Stability of such workings and seepage of water shall be regularly monitored by senior officials including manager.

2. Mine entrances

Mine entrances shall be built of adequate strength away from a fault or crack. Their lowest part shall be atleast 3m above the HFL. Deep drains shall be provided around the entrances to prevent entry of surface water.

3. Monitoring of HFL

If HFL of river or *jore* rises due to obstruction in their path due to dumping of OB, accumulation of flowing trees, construction of new bridge, increase in catchment area or unusually heavy rains, the danger shall be reviewed and additional precautions taken as required. Permissions obtained from DGMS shall also be reviewed.

4. Embankment

If mine entrances, bore holes and subsidence area are within 1.5 m of the HFL, an embankment of adequate size and strength shall be made. Height of embankment shall be at least 1.5 m above HFL. (As per DGMS directive, in case of major rivers, like Damodar, height of embankment above HFL should be 3 m). For rainwater to flow into the river, pipes with non-return gate valve shall be provided in the embankment. Efficiency of non-return valve shall be checked before monsoon and periodically during monsoon. Water side of embankment shall be stone pitched , especially at turning points.

5. Monitoring of water level

Water danger level and withdrawal level shall be marked on a concrete or steel pillar erected near the river or *jore*. Arrangement shall be made for monitoring the water level by providing guards, telephone, light and float alarm.

Standing Orders shall be made for withdrawal of men from the mine when water level reaches the withdrawal level. Rehearsals shall be conducted from time to time to acquaint the staff & workmen with the Standing Orders and to test efficacy of emergency response.

6. **Closed or abandoned shafts etc**

   Closed or abandoned shafts, potholes and subsidence cracks near a source of water shall be sealed by concrete or concrete walls and garland drains shall be provided around them. In u.g. galleries connected with O/C mine, dam shall be built. All surface bore holes shall be kept sealed by concrete plugs of full depth of boreholes.

7. **Subsidence area**

   Subsidence area shall be so sloped that water flows out. Embankment and deep garland drains shall be made around the subsidence area to prevent entry of outside water.

8. **Water tank on the rise side**

   The sides/ embankment around any water tank or pond on rise side of mine entrance or subsidence area shall be kept maintained.

9. **Workings at shallow depth**

   No working shall be made where thickness of hard strata is less than 7.5m. Where thickness of hard cover is 7.5 to 15m, permission shall be taken from DGMS and work shall be done following the specified precautions. A barrier of 7.5 to 10m shall be left on either side of the fault.

10. **Mine barrier**

    Mine barriers in all seams shall be vertically above one another to prevent transference of danger from adjacent mines.

11. **Review of safety measures**

    A competent person shall review the safety measures once in 14 days and in rainy season, once in 7 days. A record of inspections shall be maintained.

12. **Precautions before and during rainy season**

    Inspection shall be carried out and safety measures against inundation shall be reviewed before onset of monsoon. Embankment shall be inspected and strengthened. Garland drains shall be cleaned and repaired. Obstructions in the course of river/ *jore* shall be removed. Arrangements for monitoring of water level shall be checked. Production area shall be planned. During heavy rains, senior officials including manager shall inspect the vulnerable places and review the safety measures. If there is a dam on upstream side of a river, liaison shall be maintained with the dam authorities to know when water is being released from the dam. Persons shall be withdrawn from the mine promptly in case of danger.

Q. 9. Write a short note on highest flood level (HFL). (1992)

Highest flood level (HFL)

When it rains, water level of a river or *jore* rises and water spreads on both sides. The rise varies from year to year. The highest level in known history to which water has risen is known as highest flood level or HFL of river/ *jore*. The outer border to which the water spreads on either side is called highest flood line.

If there is a river or *jore* near the mine, HFL is noted in mine plan with date, month and year, as 'HFL 305m (5.10.2006)'. It gives an idea of the extent to which the water can spread so that safety of mine entrances can be ensured. HFL is painted on a concrete pillar built on the surface. Every year during rainy season, the surveyor checks whether the water level has risen to a level higher than HFL, and if so, he surveys the HFL line, amends all mine plans accordingly and reviews the danger.

It is to be noted that HFL line is not a contour line. In different mines on the same river, HFL may be different because width and depth of river may not be the same at all places.

Note : River means any stream or current of water, whether seasonal or perennial, and includes its banks extending upto the highest known flood level.

Q. 10. If a mine is having danger of inundation from surface sources, what precautions shall be taken before the rainy season and during the rainy season?

Precautions before the rainy season

1. Water danger plan shall be updated and studied to review

the places where water can enter into the mine. On the basis of history, the maximum rainfall on a day is noted, safety measures adopted in the previous year are reviewed to ensure their adequacy in the current year. These measures shall be discussed in a meeting of the manager with assistant/under-manager, engineer, surveyor, experienced overman, mining sirdar, workmen's inspectors and workers and a time-bound Action Plan shall be prepared. Responsibilities of different officials shall be fixed.

2. Removing obstructions from the water courses.
3. *Matti*- filling, levelling of depressions, drain cutting and making embankments around low lying areas, subsidence, cracks, potholes and areas where subsidence many take place.
4. Mine entrances shall be atleast 1.5m above the HFL. Strengthening of mine entrances where required, cleaning and deepening of garland drains around the mine entrances, drainage arrangements so that there is no possibility of water entering winding engine house or sub-station. Sealing surface bore holes.
5. Inspection and repair of embankment built against river or *jore*.
6. Re-painting of the HFL, danger level and withdrawal level and alert level on concrete pillar. Arrangement of lighting, telephone and guard room, fixing automatic float switch so that an alarm rings in attendance room and manager's office and residence, when water reaches the withdrawal level.
7. Mock rehearsal to keep the workmen conversant with the standing orders.
8. Maintenance of pumps, motors, electricals, power lines, arranging adequate capacity of pumps, delivery ranges and sumps, availability of spare parts are some other aspects to be attended to.
9. Arranging manpower for monitoring of water level, inspection of embankments, overhead lines, running and maintenance of pumps etc.
10. Mine areas to be worked during the rainy season shall be planned.

Precautions during the rainy season

(a) Periodical checking of embankment, subsidence areas and all safety measures.

(b) Inspection of vulnerable areas during heavy rains by manager, under-manager, experienced overman and mining sirdar to ensure proper drainage of rain water.

(c) Surprise inspections by senior officials and manager during the night to check the alertness of river guard and other personnel.

(d) Liaison with dam authorities if there is a dam on the upstream side of the mine to get pre-warning of release of water from the dam. Alertness to forecasts of heavy rains by weather department.

(e) Timely withdrawal of workmen from the mine in case of danger.

(f) Monitoring of seepage of water u.g. In case of abnormal seepage, men shall be withdrawn and the reason shall be ascertained. Information shall be sent to Regional Inspector.

Q. 11. In an O/C mine situated near a *nalla*, what precautions will be taken to prevent inrush of *nalla* water into the mine in rainy season? (1985, 1989, 1997)

Precautions against inundation of OC mine

1. **Assessment of danger and preparation of action plan:** Water danger plan shall be updated and reviewed before onset of monsoon to check places where water can enter into the mine. A time-bound action plan shall be prepared of the precautions to be taken, responsibility-wise, reviewing the precautions taken in the previous year and physical changes since then.
2. **Inspection of *nalla*** : The *nalla* shall be inspected all along its length and it shall be cleared of all obstructions (trees, OB etc), especially at the cross overs or bridges.

   It shall be ensured that there is no blockage in the river path. (In 1997, Ledo Colliery was drowned due to blockage of path of the adjacent river due to OB rolling down from the nearby OB dump – although mine entries were sufficiently above HFL.)

3. **Inspection of embankment :** Embankment along the *nalla* shall be inspected all along its length. Any cracks, crevices, damages shall be repaired to ensure its stability. Arrangement shall be made for frequent inspections during monsoon.
4. **Safe distance from embankment** : Workings shall be advanced only upto a safe distance from the embankment, otherwise the embankment will get damaged and mine will be drowned. (reference : inundation of Umrer Opencast in 2010)
5. **Inspection of surface drainage :** Contour plan shall be studied and the area shall be inspected to arrange cleaning and repair of drains and making of new drains to ensure that the rain water will flow out and shall not come to the mine. Garland drain around the quarry shall be cleaned, deepened or a new drain made if required. It shall be ensured that water does not accumulate and does not flow into the mine from quarry sides, because it may cause side fall and provide additional path for entry of water.
6. **Monitoring of water level :** HFL, danger level and withdrawal level shall be marked on a concrete or steel pillar by the side of the *nalla*. Guards and mining sirdars shall be posted in all the three shifts to monitor the water level. Arrangement for lighting, telephone and torches shall be made. Automatic float alarm shall be installed to alert the attendance clerk and the manager when water reaches danger level.

   During heavy rains and night hours, manager and senior officials shall make surprise inspections to check alertness of the personnel and safety of the vulnerable places.
7. **Standing Orders :** Standing Orders shall be drawn, discussed and copies given to all officials. Rehearsals shall be conducted from time-to-time. Availability of a dozer and dozer operator shall be ensured to change the course of water during heavy rains if required. Wireless, walkie-talkie, and telephone systems shall be made fully functional. Arrangements for transportation of men shall be made.

Q. 12. Write manager's Standing Orders for immediate action to be taken in a mine situated close to a river to guard against danger of inundation. (1992)

Standing Orders against inundation

Giving warning

1. River guard will keep a continuous watch on water level. When water reaches the danger level marked on the pillar, the river guard will immediately inform the attendance clerk over telephone. (River guard shall be provided with an assistant when the river/ *jore* is in flood, for conveying the message).

   River guard shall also note down the water level at every half-an-hour until water level falls below the danger mark.
2. Any person noticing an unusual seepage or flow of water u.g., shall at once intimate the nearest mining sirdar, overman or any other mine official. If he is employed near the pit bottom, he shall inform the onsetter.
3. Attendance clerk, on receipt of flood warning, from river guard or from automatic warning system, shall inform by fastest possible means—
   - (i) banksman, or in case of incline mine, nearest mining sirdar u.g.
   - (ii) senior official, in particular the manager if he has not reached the control room by that time.
   - (iii) members of colliery emergency team by blowing the siren.
4. Banksman, on getting the flood warning, shall inform the onsetter. If telephone is out of order, he shall give information by shaft signalling system. He shall also send information to the nearest mining official, without leaving his place of duty.

   Mining sirdar, overman or other official, on receiving flood warning, or apprehending imminent danger, shall send the warning to other parts of mine for withdrawal of persons.
5. On receiving information, members of colliery emergency team shall reach the control centre.
6. Manager shall arrange to inform the agent or other senior officials of the company and the Chief Inspector. He shall take control of the emergency control centre.

Withdrawal of persons

7. On getting flood warning or on suspicion of imminent

danger, mining sirdar and / or overman shall forthwith withdraw from the mine, all persons under his control without creating panic. He shall himself bring up the rear.

Persons shall be withdrawn by the shortest safe route, whether ordinarily used as travelling roadway or not. Emergency route shall be pre-selected and demarcated.

Senior mine officials shall exercise general supervision over withdrawal of persons.

8. If any person has not been evacuated, the attendance clerk shall inform the manager, who shall take appropriate steps.

Admittance of persons

9. No person, other than those permitted by manager, shall be allowed to remain or enter the mine.
10. Normal work shall not be resumed except with the written permission of the manager, and unless all working places have been thoroughly examined as per Reg.113.

Other steps

11. A record of every such occasion shall be maintained in a bound book kept for the purpose.
12. A copy of the Standing Orders shall be posted in mine office, attendance room and the mine entrance.
13. Mock rehearsals shall be conducted atleast once in every month during the rainy season (15th June- 31st Oct).

Q. 13. What is Burnside Boring Machine? Describe briefly with a sketch and mention method of its installation & working.

OR

Write a short note on Burnside Boring Machine. (2014)

Burnside safety boring machine

It is a special boring machine for safe drilling of bore holes at any angle underground against water logged workings for (a) determining thickness of barrier, (b) tapping and draining water, and (c) making advance holes when driving exploratory headings. Special features of the machine are:

(a) Flow of water met can be regulated/controlled/stopped when rods are in the hole.

(b) Drill rods can be withdrawn and flow of water stopped or controlled while the bore hole is under pressure.

Description

The machine is usually trolley-mounted and in two units – drive unit and drilling unit. Construction and main parts of drilling unit are shown in the figure. Typically boring rods are of 38 mm dia, 1.5 m long, fitted in the front with 56 mm tungsten carbide tipped bit. Reamer has dia 110 mm.

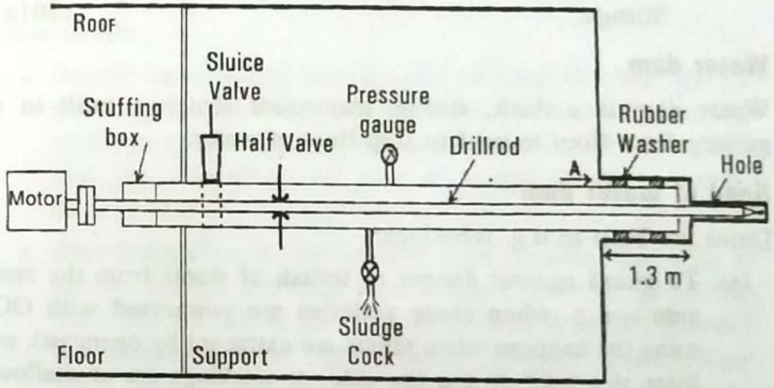


Fig : **Safety Boring Machine**
('A' shows arrangement to press rubber washers)

Installation & working

A normal hole, 56 mm dia, about 2 m long is drilled in the desired direction. First 1 m is reamed to 110 mm and a stand pipe is inserted. It is secured to the strata by rubber sealing bushes which are expanded by being compressed between a fixed ring and a few loose brass rings drawn together by long bolts.

To commence drilling, drill rods are pushed in through the stuffing box and valves. On starting the motor, drill rods coupled to it rotate. As drilling progresses, more rods are added outside the stuffing box. Drill cuttings fall through the sludge cock.

When water is tapped, the two rubber-faced clamp type half valves are closed to prevent discharge of water. To withdraw drill rods, clamps are released. Water pressure forces the rods out to expose a joint to detach a drill rod. Process is repeated until all drill rods have been withdrawn. Full bore valve (sluice valve), through which rods operate, is then used to stop or control flow of water.

Note : Besides Burnside Boring machine (of U.K. make), well known safety boring machines are Craelius and Longyear. In India, Voltas manufacture such machines under trade name Volsafe (for water head upto 500 m).

Q. 14. Write a short note on water dam. (1983,1987, 1994)

Write a short note on need of water dam and its essential fittings. (2014)

Water dam

Water dam is a thick, strong, leak-proof structure built in a gallery from floor to roof to stop flow of water.

Need of water dam

Dams are built in u.g. workings:

(a) To guard against danger of inrush of water from the rise side – e.g. when some galleries are connected with OC mine (as happens when pillars are extracted by opencast), or there is a goaf on the rise side, or workings are at shallow depth and there is danger of inrush of surface water through cracks & potholes, or there are interconnections with upper seam likely to be flooded during rains.

(b) To guard against irruption of water from adjacent old workings. e.g. when barrier is of inadequate thickness.

(c) To hold water during rains for pumping it out slowly in later months.

(d) To store water on the rise side for use as and when required.

Legal requirements

- 14 days prior to construction of dam, a notice is to be sent to Regional Inspector giving details of position, design and construction. He may require amendments in the design.
- Dam is built under personal supervision of an Assistant Manager or a graduate civil engineer.

Site & design

Site of dam should be stable, without danger of crush, free of faults, cracks, slips & other weaknesses. It should be as far on the inbye side of the pillar as possible. The place should be approachable throughout life of the mine.

Dam may be flat or spherical, of brick or concrete. Thickness depends on head of water, size of gallery, nature of strata, dip of seam and materials of construction. It is designed by competent & qualified civil engineer. There are many formulae for calculating thickness. Minimum thickness of brick dam is 1.8 m and of concrete dam 1.5 m.

Construction

- Before constructing dam proper, to keep the site dry , a retaining wall 0.6 to 1 m high is built across the roadway on inbye side of the dam site , and a drain pipe (75 to 200 mm dia depending on rate of water flow) is passed through it.
- Dam foundation is cut in roof, floor & sides manually as per the design and then dam is built. Several 30-50 mm dia pipes are left in the dam for cement injection to make the abutments water tight. Cement injection is carried out from bottom upwards to a pressure of 2.5 times the expected water pressure.
- Drain pipe has several flanges so that pipe is firmly embedded in the dam. A pipe 20-25 mm dia is placed through the dam near the roof for escape of air as water fills the roadway. It is fitted with a valve and a water pressure gauge.
- Roof of roadway on either side is kept supported by girders.

Essential fittings

- Dain pipe (non-corrosive) of adequate size, fitted with stop valve.
- Air vent pipe (20-25 mm dia) with stop valve and a water pressure gauge.
- Check board.

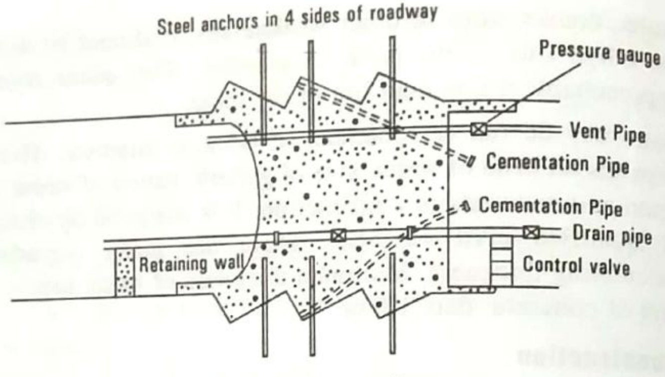


Fig : **Plain Concrete Dam**

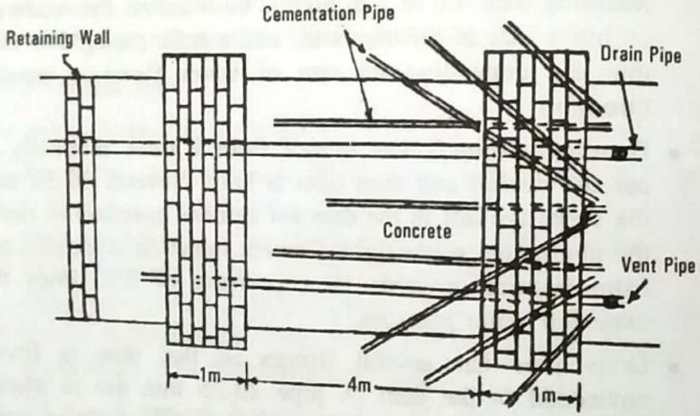


Fig : **Brick dam**

Q.15. What precautions shall be taken in dewatering mine workings?

Precautions in dewatering mine workings

1. De-watering work shall be done under supervision of an overman.
2. Only approved safety lamp shall be used at the site.
3. A flame safety lamp (FSL) shall be kept burning at every place where persons are employed.
4. Good ventilation shall be arranged.
5. First inspection of mine or part after de-watering shall be done by competent person with a FSL.

6. Results of inspection shall be recorded, signed and dated by overman, and countersigned by manager.
7. Towards the end, water shall be pumped slowly to prevent a water blast due to pressure of air compressed in rise side workings.
8. Exposed dip galleries shall be cleared of water and muck lest they become a source of danger (as happened in 2004 in Jamadoba Colliery). Slurry pumps shall be used to pump out muddy water.
9. As workings are exposed, they shall be inspected for security of roof and sides, and presence of CO, CO_2, H_2S, CH_4. Dressing, strengthening of supports and repair of ventilation stoppings shall be undertaken.
10. Overman shall write a daily detailed report in a bound paged book kept for the purpose which shall be countersigned **daily** by the manager.
11. Irrespective of degree of gassiness, motors and all other electricals shall be flame proof.

Note : If water-logged workings of overlying seam are de-watered by boreholes,

- At bottom of each upward borehole, a U-shaped pipe bend shall be fitted. The bend shall be kept filled with water to act as water-seal which would prevent leakage of air or foul gases from travelling to/from overlying workings.
- A record of quantity drained shall be kept to compare it with estimated volume of the water body.

Q. 16. What is water danger plan? What features are shown in it? (2005)

Water danger plan

Water danger plan is a plan which shows all places that are water logged, or can become water logged, and all information required for assessment of water danger in mine. It includes the following :

1. position of mine workings.
2. position of every bore hole, shaft, drift, every geological disturbance, subsidence area, fault.
3. spot level of every junction of haulage roadway, and at end of the headings; stratum contours.

4. every source of water, such as river, *jore*, reservoir, waterlogged O/C workings and the outline of waterlogged workings lying within 60m of any part of the workings measured in any direction.
5. surface contours at vertical interval not exceeding 5m (not exceeding 10m where there are no workings belowground), over the whole area lying within 200m of any part of the workings
6. surface drainage system.
7. HFL.
8. reduced level of permanent bench mark.
9. every goaf and pumping station, seam sections, every sump and water dam (with details of construction and reference of permission etc.)
10. warning lines to draw attention to danger of inundation by surface water, unconsolidated strata, water bearing strata, and u.g. water.
11. cross sections of river and water courses.
12. incline openings through O/C workings.
13. statutory restriction line.

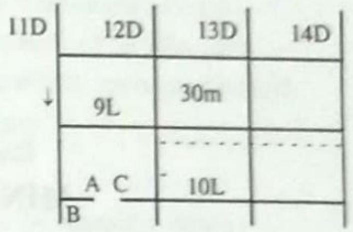
Q. 17. Assuming your own conditions, write giving a sketch, a report of an accident due to sudden inrush of water in a development gallery. (1986)

Report of inundation in development workings

An inundation occurred in development district of a mine, resulting in death of 4 persons under the following circumstances:

District—As shown in the sketch, development of the 11 dip section had been done upto 10th level, but the 2 faces A and C had not joined. The workings remained stopped for 6 months and the water level rose a little below 9L. Work was resumed in faces A and B after pumping out water by pumps installed in the 11th dip. The parting between A and C was about 20m.

The manager decided to advance the face A for 15m and then drill a hole to release the water to 11 dip for pumping.



Accident—On the fateful day, after doing 2 rounds of blasting, in second shift mining sirdar noted seepage of water at face A and informed the manager of the same. The manager advised to continue work as atleast 14m parting was still left. Third shift mining sirdar and overman were not vigilant. Soon after a blasting in face A, accumulated water and muck rushed through a puncture 1.2 x 0.9m. Loaders working in face A ran out through the 11th rise, but those working in the dip face B slipped and got drowned. Water level reached a little above the 10th level.

On pumping, the parting between A and C was found to be only 0.3m.

Violations

1. Drivage to water-logged workings within 60m attracts Reg.127. Before attempting to connect the water should have been dried out by installing pumps on the other side.
2. According to Reg.127, on discovering abnormal seepage of water, work is to be stopped and information is to be sent to DGMS, which was not done.
3. Plan prepared by the surveyor was grossly inaccurate.
4. Manager, mining sirdar and overman of third shift lapsed in their statutory duties.

●

Chapter 18

MINE FIRES

Q. 1. What is spontaneous combustion? Which places in a mine are likely to develop spontaneous combustion?

Spontaneous Combustion

Spontaneous combustion of coal is the process of self heating resulting eventually in its ignition without application of external heat.

When coal is exposed to air, it undergoes slow oxidation even at normal temperature producing CO, CO_2 and some heat. Heat evolved is not perceptible, as it is carried away by air. However, if heat is not carried away fast enough (because of coal being covered by fall of roof etc.), there is gradual build up of heat and rise in temperature of coal. At the raised temperature, the process of oxidation is accelerated and some other fractions of coal become susceptible to oxidation. Gradually the coal reaches ignition point and breaks up into flames if sufficient O_2 is present.

Places likely to develop spontaneous heating

u.g. mine :
- Goaf
- Unused or old workings where fallen coal has accumulated
- Pillar adjoining a fault (as it is loose and fractured coal)
- Pillars crushed due to over riding
- Goaf at a shallow depth, which has access of air through surface cracks
- Crushed/cracked pillar between intake and return airways

O/C mine :
- Exposed coal bench (where there are cracks due to back-break by bad blasting and the face is not advancing)
- Burning fire, dumping hot ash over exposed coal.
- Loose coal accumulated at the base of an idle face.
- Developed pillars being extracted by opencast method.
- OB dump containing coal, shale.

Surface : Coal stock

Q. 2. What are the causes of fires in opencast mines?

Causes of fires in OC mines

Major cause of fires in opencast mines is spontaneous heating. It occurs under the following circumstances:

1. Development of cracks in exposed coal benches due to back breaks/side breaks on account of poor blasting.
2. Allowing loose coal to accumulate at the toe of an idle coal face.
3. Presence of inferior coaly matter and shale in overburden dumps.
4. Large stocks of coal.
5. Extraction of developed pillars by opencast.

Other causes of fires are :

1. Burning fires/ dumping hot ashes on outcrop of coal or exposed coal.
2. Fires in diesel and electric HEMM due to poor maintenance.
3. Fires in diesel operated HEMM while extracting blasted coal of developed pillars.

Q. 3. How are underground mine fires classified? List the causes of accidental mine fires.

Underground mine fires are classified into 2 categories :

- Accidental fires
- Fires due to spontaneous heating.

Causes of accidental fires

- Fires in equipment like SDL, LHD.
- Belt conveyor fires due to belt friction at a ceased drum or over heated fluid coupling.
- Electrical fires in switch gears and cables due to short circuits and sparks.

- Blown out shots causing fires in brattice.
- Fires due to welding in shafts or head gears: hot material falling on inflammable material/coal dust.
- *'Ban tulsi'* conflagration : dry vegetation in the outcrops of coal seams and quarries catch fire easily which spreads to coal.
- Illicit distillation of liquor in abandoned inclines and quarries.
- Negligent acts : like making soft coke over subsided areas, edges of quarries and outcrops of coal seams.
- Damaged/misused flame safety lamps.
- Explosions causing fires in the mine.

Q. 4. (a) Discuss measures to detect spontaneous heating in early stages in u.g.mine.

(b) Explain the sensory indications of spon. heating in u.g.workings.

Detecting spontaneous heating in early stages

1. Return air of every depillaring distt. and goaf area not isolated–
   (a) shall be tested for **% of CO** once in **7 days** with an approved automatic detector, and
   (b) completely analysed once in **30 days** to determine Graham's ratio **CO formed/ O_2 absorbed.**
   Results shall be recorded.
   If successive tests show **steady increase** of CO formed/ O_2 absorbed, the site of heating shall be searched out to deal with it.
2. In seams liable to spontaneous heating, telemonitoring system may be installed for continuous watch on CO%.
3. Every **depillaring distt.** shall be inspected on **idle day.**
   - **Unused workings :** at least once in **7 days,**
   - **Isolation stoppings** around goaved out areas and unused workings : atleast once in **7 days.**
4. **Subsidence** areas over depillaring distts. shall be inspected once in **7 days** for any indications of spon. heating.

Note : All these inspections are done by overman. Frequency is increased if mine condition warrants.

Sensory indications of spontaneous heating u.g.

Sensory indications (in order of progression) in the incipient or initial stage are :

(a) *Faint haze,* produced by moisture driven off from coal coming in contact with cooler air some distance away from the heating and getting condensed.

(b) *Sweating* of roof, sides, timbers and metal surfaces–due to moisture coming in contact with these cooler surfaces, getting condensed and depositing on them in the form of droplets. Sweating occurs at advanced stage after formation of haze.

(c) *Typical faint odour,* known as 'gob stink'–slightly oily, sometimes sweet, sometimes like the smell of decaying timber–due to evolution of some hydrocarbons. Smell is recognised when coal temperature increases to over 120^0C.

(d) *Slight discomfort and uneasiness to men* near the site of heating because of increased temperature and humidity. The discomfort is exhibited by tickling in nose, increased secretion of saliva in mouth and 'dry throat'.

As heating develops, the above symptoms become stronger and petrolly smell in given off. As heating approaches ignition, petrolly smell changes to tarry odour, and later smoke may also be seen.

Q. 5. Write short notes on :
Graham's Ratio (or Graham's Index) (1998,2002)
Incubation period (1998, 2003)

Graham's Ratio

In any u.g. coal mine, even at normal temperatures some oxidation of coal takes place. In this process, some O_2 is consumed and CO is produced. The ratio CO produced/O_2 consumed, known as Graham's Ratio or Graham's Index, for a mine remains more or less constant. If spontaneous heating occurs, there is steady rise of the ratio with increase of temperature. The ratio can, therefore, be used as a guide to detect heating.

Regulations prescribe that the return air of every depillaring distt. shall be analysed at least once in every 30 days to determine the Graham's Ratio. If successive tests show steady increase in the ratio, steps shall be taken to determine the site of heating and to deal with it.

Note : 1. Graham's Ratio is generally expressed as percentage.

i.e. Graham's Ratio = $\frac{\text{CO produced}}{\text{O}_2\text{ consumed}} \times 100$

2. CIMFR scientists have found that in case of Indian coals, the normal ratio for mines generally lies between 0 and 0.1%. Even a small steady rise to 0.5% may indicate heating, over 1% serious heating, 2% or more active fire. Ratio may go even upto 10%. In other countries, the normal is found to be between 0 and 0.5%, and a rise to 1% indicates development of heating, 2% indicates active fire.

Incubation period

This is the period between the time when coal is first subjected to conditions favourable for spontaneous heating and the time of getting indications of heating.

In a depillaring panel, worked by caving, conditions favourable for heating develop when the first major roof fall occurs, because fallen/crushed coal starts heating but the heat does not escape as coal is covered by shale and stone. Date of first major fall in the panel is therefore recorded. Action is then taken to ensure that depillaring operations in the panel are over before end of the incubation period and it can be sealed off by stoppings well in time.

Incubation period cannot be measured by any instrument. It is judged by experience gained in the mine or in adjacent mines working the same seam.

Size of panel (no. of pillars) is kept such that all coal extraction is completed within the incubation period.

Incubation period varies from seam to seam. In Jharia coalfield, it is generally 9 to 12 months, in Assam coalfield 2 to 6 weeks.

Q. 6. What are the causes of spontaneous heating in a coal mine belowground? Suggest measures for early detection of spontaneous heating. (2009)

Causes of spontaneous heating belowground

GOAF

1. Large quantity of coal left in the goaf.
2. Exposure of left over coal to air because of,
   - Roof not settling due to standing ribs/stooks
   - Incomplete stowing
   - Non sealing of subsidence cracks & pot holes
   - Leakage of ait through inter seam parting in contiguous workings
   - Entry of air through unplugged surface bore holes over goaved out panel
   - Entry of air through barrier with opencast working
3. High pressure differential across sealed goaf
4. Extraction of coal beyond incubation period

DEVELOPED WORKINGS

1. Side spalling due to small pillars, wide and high galleries
2. Fallen coal lying in old workings
3. Poor ventilation
4. Not keeping the workings isolated.
5. Using coal as track packing material
6. Using coal mixed stone as packing material in air crossing.

Measures for early detection

1. In return of every depillaring district and of every un-sealed goaf,
   (a) measuring % of CO by approved automatic CO detector at weekly intervals,
   (b) drawing air samples for analysis to determine CO/O_2 deficiency ratio every 30 days; if the ratio is found steadily increasing, taking measures to locate the site of heating and to deal with it.
2. Inspection by competent person
   (a) Inspection of every depillaring district on idle days/holidays.
   (b) Inspection of unused workings which have not been sealed off, at weekly intervals.
   (c) Inspection of isolation stoppings, once a week.
   (d) Inspection of subsidence area over caved goaf, once a week.
3. Installing telemonitoring systems in seams highly liable to

spontaneous heating to keep a constant watch on % of CO and CO/O_2 deficiency ratio.

Q. 7. What precautions will you take :
To prevent spontaneous heating in the mine? (2010)

Precautions to prevent spontaneous heating

Depillaring

1. Depillaring with panels of such size that extraction can be completed within incubation period.
2. Speedy extraction.
3. Minimising coal left in the goaf.
4. Blasting the stooks/ribs left in goaf to ensure regular fall of roof and goaf consolidation.
5. In BG panels, injecting CO_2 or N_2 from time to time.
6. Not leaving stowing lag in goaf.

Sealed goaves

1. Good construction, regular inspection and timely maintenance of isolation stoppings.
2. Keeping pressure differential across sealed off areas low to prevent leakage of air.
3. Blanketing the surface over goaved panel. Crack filling and consolidation from time to time.
4. Regular air sampling and analysis to keep a watch on condition in sealed off area.

Unsealed developed workings

1. Doing skeletal development upto the boundary, and then simultaneous development/depillaring to eliminate the problem of old developed workings.
2. Keeping old developed workings isolated.
3. Regular removal of fallen coal and thick stone dusting.
4. Ensuring adequate ventilation.

Opencast workings

1. Regulating the blasting to prevent over breaks/cracks in coal seam/exposed coal.

2. Preventing accumulation of loose coal on exposed idle benches.

Coal stock

1. Dispatching old coal before the fresh coal.
2. Consolidating the stock by dozer from time to time.

Q. What are the causes of spontaneous heating in underground coal mines? Throw light on measures for its prevention and early detection in a large depillaring area? (2013)

See questions 6& 7 above.

Q. 8. What will you do–
On detecting a peculiar smell in the return airway of a district being worked by open caving? (1995)

Smell in return airway

On development of spontaneous heating in the goaf, a peculiar oily, sweetish or petrolly smell is found in the return airway. On getting such a smell, the following steps will be taken :

1. Send information to :
   - (a) overmen/mining sirdars of other districts to withdraw men to surface,
   - (b) the surface, particularly the manager,
   - (c) any senior official who may be present u.g.

Whenever possible, the information shall be given over telephone.

2. Withdraw men from the mine, and send them out through intake airway and downcast shaft, without creating chaotic conditions–keeping underground only the minimum persons who may be required for dealing with the fire e.g. line mistris and helpers, timbermen and helpers, mazdoors etc.
3. Cut off electrical power of the district.
4. Engage men retained u.g. in preparatory works for sealing off the fire. Take care of their safety.
5. At end of the shift, write a detailed report in the bound paged book kept under Reg.114 (Avoidance of dangers), and confer with the manager/asstt. manager.
6. No person shall be re-admitted, except for dealing with the fire, until the fire in extinguished or effectively sealed off,

and the mine declared safe after inspection by asstt./UM/ manager.

Q. 9. What precautions will be taken while sealing off a fire area? (1993)

Precautions while sealing off a fire area

1. Work shall be done as per a scheme prepared by the manager.
2. A competent person (overman or assistant manager) shall be present on the spot throughout.
3. Roadways between seat of fire and stoppings shall be thoroughly stone dusted before commencing work of sealing.
4. Following items shall be kept at or near the site of sealing:
   (i) Adequate number of self rescuers and atleast 2 smoke helmets,
   (ii) A cage containing suitable birds or approved CO detector,
   (iii) A flame safety lamp or other approved means of detecting CO_2 and oxygen deficiency.
5. Where seals are being made, frequent checks shall be made for presence of CO and O_2 deficiency to prevent danger to persons working.
6. During sealing operations with ordinary men, a Rescue Team shall be kept stand-by.
7. Affected area shall be isolated quickly by erecting temporary stoppings of sand bags, cgi sheets etc. Permanent stoppings shall be built after a lapse of atleast 24hours during which period methane may reach explosive limits.
8. Ventilation shall be maintained to the fire area to prevent building up of inflammable gases to a dangerous level. The last intake and return stoppings shall be closed simultaneously preferably by closing small steel doors provided in the stoppings.
9. A competent person shall be posted on the return side of the affected area to keep a check on CH_4 %. Men shall be withdrawn if it reaches explosive limits.

Q. 10 (a) What are the dangers involved in re-opening a sealed off fire area? (2009)

(b) What precautions should be taken while re-opening a sealed off fire area?

Dangers in re-opening sealed fire area

1. Fire may revive on admission of air.
2. There may be firedamp explosion.
3. Danger from CO, CH_4 to persons engaged in re-opening; danger from high temperature/high humidity.
4. Danger from inflammable/noxious gases in the return airways and near main fan evasee.
5. Danger of roof falls.

Precautions in re-opening

A. Notice and scheme of re-opening

When samples of air drawn from sealed off fire area at regular intervals, over a long period of time, indicate that the fire is extinct, minimum 14 days' re-opening notice shall be sent to Regional Inspector. A scheme of re-opening shall be prepared with his advice.

B. Preparatory arrangements

1. Reaching adequate quantity of bricks, cement, sand, empty gunny bags, CGI sheets, and roof support materials near an intake and a return stopping to be breached.
2. Making air locks outbye these two stoppings.
3. Arranging adequate quantity of air upto the air locks.
4. Stonedusting heavily the area upto 4 pillars outbye the stoppings.
5. Extending upto the stoppings, water pipe range with adequate water pressure, and ensuring availability of pipe fittings/tools.
6. Making arrangements for drawing air samples and speedy analysis.
7. Deciding workers, supervisors and executives to be engaged for re-opening work and deciding their work allocation.
8. Arranging rescue teams and equipment, testing and sampling instruments.

C. Emergency organisation

1. Work shall be planned to be done on an idle day. Emergency

organisation shall be set in motion, including control room on surface and fresh air base underground with telephonic communication.

2. Only minimum number of persons required for re-opening shall be allowed u.g.
3. Constant availability of electricity shall be ensured.
4. Return airways and area upto 45m from the fan evasee shall be fenced.
5. Accommodation shall be made available for rescue teams/equipment.
6. Co-ordination shall be made with rescue station.
7. Shift-wise duties of workers/supervisors/executives shall be allotted.

D. Re-opening

1. A limited area of intake and return stoppings shall be broken by ordinary workers under rescue cover, and a small quantity of air shall be allowed to circulate through the sealed off area. Proper arrangement shall be made for safety of workers against noxious/inflammable gases.
2. Simultaneously air coming out of the return stopping shall be tested by gas detectors at 30 minute intervals and air samples drawn by an executive especially posted for the purpose. Samples shall be sent for analysis.
3. When air samples indicate that conditions in the sealed area are safe, the intake and return stoppings shall be broken fully to arrange full ventilation of the sealed area.
4. The area shall be inspected by overman/mining sirdar accompanied by the rescue team. Necessary dressing/support work shall be done. Any smouldering material shall be cooled by water.
5. Once the area becomes safe in all respects, it shall be inspected by the manager before ordering normal work in the mine.

Q. 11. Describe the equipment and organisation for fire fighting in a mine.

Equipment and organisation for fire fighting

1. Water

Adequate quantity of water at sufficient pressure shall be made available at all working places u.g. and all other places of fire risk. Taps shall be provided at not more than 120m apart. Hose pipes of not less than 60m length shall be available at suitable places.

2. Fire station

Fire station, with suitable fire fighting equipment, shall be established and kept maintained at convenient places, on surface and u.g.

3. Sand, incombustible dust, fire extinguishers

Sufficient supply of sand, incombustible dust and portable fire extinguishers shall be provided at–

- (i) entrance to every district, landing, shaft bottom and entrance to mine.
- (ii) every place where timber, grease, or other inflammable material is stored.
- (iii) every engine room, electrical gear, drive unit of roadway conveyor, diesel engine maintenance workshop, oil filling station, battery charging station.
- (iv) other places of fire risk.

4. Fire fighting plan

A fire fighting plan shall be made on a scale of 1:2000 showing water mains, taps, fire stations, pumping stations, ventilation system, escape routes etc. Copies of the plan shall be posted in the mine office and at suitable places u.g.

5. Training

Adequate number of persons shall be trained in the use of fire extinguishers and in fire-fighting. They shall be made familiar with the location of all fire fighting equipment.

Soda-acid fire-extinguishers or water shall not be used for oil of electrical fires,

foam type shall not be used for electrical fires, and fire-extinguishers giving off poisonous or noxious gases shall not be used u.g.

6. Maintenance

A competent person shall examine all equipment, materials and arrangements atleast once a month, He shall discharge and refill fire extinguishers as often as required. Any deficiency found during the examination or otherwise shall be remedied immediately. A record shall be maintained.

7. Standing Orders

Manager shall frame standing orders laying the procedure of giving warning of fire, withdrawal of person, conduct of fire-fighting operations etc.

8. Telephones

Telephones shall be installed at appropriate places for speedy communication of information.

9. Rehearsals

Rehearsals shall be conducted once a quarter.

Q. 12. Write a short note on :
Portable Fire Extinguishers (2008)

Portable Fire Extinguishers

1. Portable fire extinguishers are required to be kept at the following places for emergency fire fighting:
    - (a) Pit bottom, working landing, entrance to the mine or district.
    - (b) Places where combustible/ inflammable material (timber, grease, oil, etc.) is stored.
    - (c) Engine room, conveyor drive head
      Electric sub-station
      Diesel filling station
      Diesel engine workshop
      Battery charging station.
    - (d) On every SDL/LHD and continuous miner.
2. (a) For fighting oil fires, soda acid extinguisher shall not be used.
    - (b) For electric fire, soda acid or foam extinguisher shall not be used.
    - (c) Extinguisher liable to give off poisonous or noxious gases shall not be used underground (CO_2 extinguisher is not prohibited).
3. A competent person shall examine every fire extinguisher once a month. He shall discharge and re-fill fire extinguishers as often as may be necessary. Any defect/deficiency shall be immediately remedied.

   He shall write a report in B.P book.
4. Adequate number of workers shall be trained in proper use of portable fire extinguishers.
5. Portable fire extinguishers are meant for use only in initial stages when the fire is small. They have to be used promptly.

Note : These days, advance type of portable High Pressure Water Mist cum CAF (compressed air foam) based fire extinguishers are available in the country. These can be used for all types of fires including oil and electric fires. Approved apparatus of these types are being installed in some mines.

(Cir.Tech. 3/2009)

Q. 13. Write short note on Fire Fighting Plan. (1993)

Fire Fighting Plan

At every u.g. mine a fire-fighting plan is to be kept maintained, and a copy thereof posted in the mine office and at convenient places belowground.

This plan is like a ventilation plan of the mine, showing in particular the following :

1. System of ventilation of the mine,
2. Position of fire fighting equipment, i.e.
    - – fire station (with details of equipment),
    - – pumping station,
    - – water pipe lines and taps.
3. Emergency exit routes.
4. Places vulnerable to fire, such as electrical sub-stations, belt conveyor drive heads, places where inflammable materials are stored.

The plan shall be kept up-dated.

Persons trained in fire fighting shall be made conversant with this plan.

Q. 14. What is meant by 'Standing Orders in the event of a fire?' Give brief description of such orders. (2005)

Standing Orders in the event of a fire

On occurrence of a fire in the mine, *speedy* and *effective* actions have to be taken to *save life* of persons and to *prevent spread* of fire. The manager, therefore, prepares standing orders specifying how the information of fire is to be communicated, to whom, and who has to take what action. On occurrence of fire, it is taken that the manager has given those orders, Copies of standing orders are given to concerned persons and posted in attendance room, pit-top, pit bottom, and other important places. These are known as 'standing orders in the event of a fire'.

Specimen of the orders

1. These standing orders shall apply to.............colliery with immediate effect.
2. **Any person** who notices a fire in the mine (or comes across smoke or smell of fire), shall take immediate steps to extinguish it if suitable material or appliances are available nearby. Where more than one person is available, one of them shall proceed for giving information to mining sirdar, overman or other official available nearest. If fire is too extensive, he shall proceed to give warning. If the person is employed near the pit bottom, he shall give information to the on-setter also.
3. **On-setter** shall inform the banksman, who in turn will inform the attendance clerk.
4. **Attendance clerk** will inform the manager, asstt./UM and engineer. He shall also sound hooter or send men to inform and get trained fire fighting personnel of the mine and key mine officials. He shall not permit any person to enter the mine without written orders of the manager.
5. **Fire fighting personnel** shall report to the attendance clerk immediately on getting information,
6. Actions by mining ***sirdar/overman***
    - Inform the onsetter and manager, preferably by telephone.
    - Withdraw from the mine all persons, excluding those required for dealing with the fire, via intake airways and downcast shaft, without creating panic.

    - Inform mining sirdars and overmen of other district districts to withdraw men.
    - Cut off electric power.
    - Use equipment/materials available to quench or control the fire, but without taking undue risk. Safety lamp and birds and CO detector shall be used to ensure safety of persons u.g. Where fire is being fought, 2 smoke helmets shall be kept available.

    He shall act promptly to prevent a minor incident becoming a major disaster.
7. **Banksman**

    He shall not allow any unauthorised person to enter the mine.
8. Duties of **manager** or principal official present
    - Set emergency plan into action.
    - Inform higher officials, Regional Inspector and Rescue Station.
    - Assess the situation and take action to locate men, save their lives and prevent spread of fire and noxious gases.
9. Resumption of normal work.

    Normal work in the mine shall be resumed only after the fire has been extinguished or sealed off and workings declared safe after inspection by manager, assistant manager/under manager and written orders issued to that effect.
10. Rehearsal

    Ventilation Officer shall arrange a rehearsal atleast once every 3 months, note the deficiencies and arrange for corrective action in consultation with the manager.

Dt.....................   Manager

.... Colliery

Q. 15. Draw a sketch of fire stopping for a gallery 4m high in deg.II gassy seam. Describe its fittings.

Fire stopping for deg.II seam

Construction of fire stopping is shown in the sketch. Normally thickness of fire stopping in deg.II seam is 1m, but since the height of gallery is 4m, an off-set of 15cm has been provided for the lower 2m portion. Foundation cutting would be 1m in coal or 30cm in shale or 15cm in sandstone.

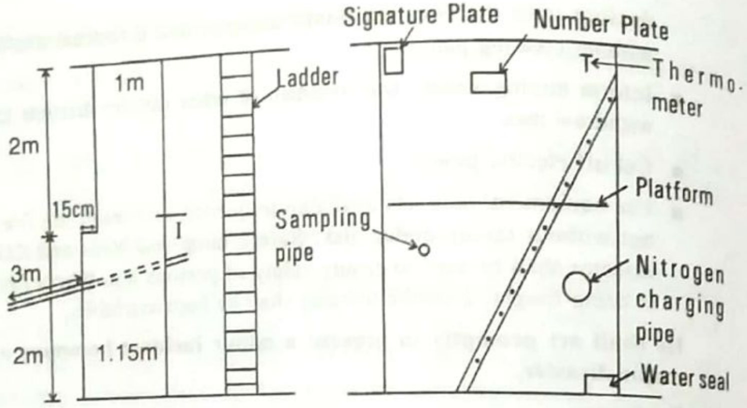


Fig : **Fire stopping**

Fittings

1. **Water seal :** Required if water is likely to accumulate behind the stopping. Water seal would consist of a pipe 75 to 125mm dia (depending on expected make of water) provided at the outbye end with a U-bend, which would be always kept immersed in water in a small reservoir built near the floor so that water may come out but air may not enter the sealed area.
2. **Air-sampling pipe :** Air sampling pipe 25mm or 50mm in dia fitted with suitable sluice valve/cap would be provided in a few strategically located stoppings, including at least one on rise side. Sampling pipe would be extended at least 3 m inbye of the stopping. Some of the sampling pipes would be placed within 30cm of the roof.
3. **Platform :** Since it is a high gallery, a platform is to be provided to facilitate inspection and maintenance.
4. **Ladder :** Although not a fitting of stopping, a bamboo ladder is essential for providing access to the platform and the sides etc. for inspection and maintenance.
5. **Tar trap :** This is provided only when water coming out from the sealed off area has a tarry smell creating false symptoms of heating. The tar trap is a perforated drum containing hard coke and sand. The sand and hard coke are replaced at regular intervals depending upon the rate of flow of water. Some mines is Jharia coalfield use tar trap.
6. **Nitrogen charging pipe :** These days in some of the fire stoppings a pipe is provided for charging nitrogen to control the heating.

7. **Thermometer :** A thermometer encased in brass casing would be embedded in a narrow slit made of cement mortar, near the top of the stopping where rise of temperature is likely to take place earlier . It will show relative temperature only and not temperature inside the sealed off area.
8. **Signature plate :** It is made of cement mortar divided in the middle by vertical line. Overman inspecting the stopping would sign starting on the left half. When the whole plate is filled up, he will wipe off the left half leaving right half signatures intact. This would enable asstt/UM/manager to see whether the inspections have been done.
9. **Number plate :** All stoppings are numbered serially for identification.

Note : 1. In deg. I seam also a similar stopping would be provided.

2. Roof and sides upto 10m on either side of the stopping shall be dressed, cleaned and supported.
3. Roof/sides upto 3m on either side of the stopping shall be cement plastered.
4. Stopping shall be kept approachable throughout the life of the stopping.
5. Samples of atmosphere in the sealed off area shall be drawn at 30 days' intervals. If inflammable gas behind the stopping exceeds 2%, a similar stopping shall be built 4.5m outbye the first one and the intervening space filled up with incombustible material to convert the stopping into an explosion proof isolation/fire stopping (as is required in case of a deg.3 gassy mine).

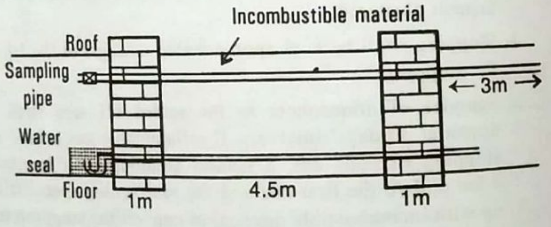
Q. 16. Write a short-note on explosion proof stopping.
(1990, 1995, 2002, 2003)

Explosion proof stopping

- In deg.III seam, to seal off a heating/fire, to enclose a depillaring panel or to isolate disused workings the stoppings have to be explosion-proof because of danger of explosion of inflammable gas by fire.
- In deg.I & II seams also, if on drawing sample from a sealed off area inflammable gas is found to exceed 2%, the

stopping is converted into an explosion proof stopping.

- Explosion-proof stopping consists of two 1m thick stoppings built 4.5m apart and the intervening space is filled with sand or incombustible material.
- The two stoppings are built after cutting foundation in roof, floor and sides to a depth of 1m in coal, 30cm in shale or 15cm in sandstone.
- Face of the stoppings and roof, floor and sides of the gallery (at least) upto 1m outbye are plastered with lime or cement mortar and kept white washed.
- It is fitted with air sampling pipe and water seal (if water is likely to accumulate behind it).
- The stopping is numbered and a signature plate provided.
- These days some such stoppings are provided with nitrogen charging pipe also.
- Roof on either side the stopping is kept well supported and the approach well ventilated, free from accumulation of water and free from obstructions to facilitate inspection and maintenance.



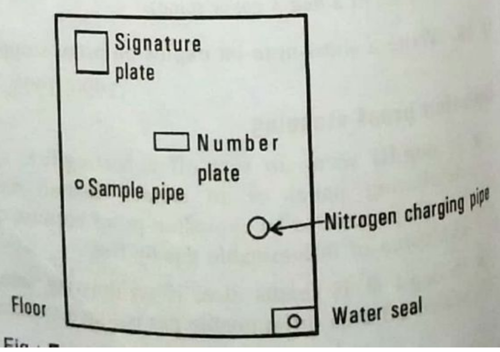


Fig.

Q. 17. (a) At what interval are isolation stoppings required to be inspected by an overman?

(b) What will you see during inspection of isolation stoppings? (2001)

Frequency of inspection of isolation stoppings

Regulations require isolation stoppings to be inspected by overman *atleast* once in every 7days. But inspection may have to be done at shorter intervals in case of thick seam, or where stopping is likely to get disturbed and leak due to strata movement. In many cases, such as when fire inside is in critical state or the stoppings are near a shaft and vital for safety of the mine, stoppings are inspected even daily.

Items to be inspected

1. General condition of the stopping.
2. Looseness of plaster by striking a stick against it.
3. Cracks in and around the stopping. Checks will be made particularly at corners, joints with roof, floor & sides, around the fittings. Cracks may be indicated by soot marks on the plaster. For this stopping should be kept well white washed.
4. Cracks in the surrounding strata, or any signs of weighting on the pillar.
5. Presence of CO, blackdamp and methane using safety lamp, methanometer, multi gas detector.
6. Valve of sampling pipe operable and properly closed.
7. No blockage of water seal pipe. Adequacy of water in water seal; water to be replenished especially in the dry season.
8. Any rise in temperature of stopping or of air issuing through the sampling pipe or of water coming out from the water seal. Temperature and humidity outside the stopping.
9. Approach to the stopping free from obstruction and accumulation of water. Roof and sides in sound condition and supports tight.

After inspection, check-board will be signed.

A report of inspection will be written stopping-wise in bound paged book kept for the purpose.

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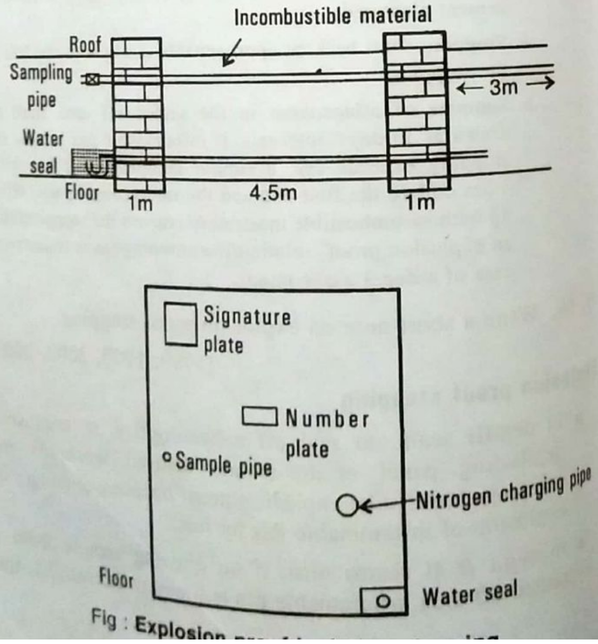

Fig : Explosion

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After inspection, check-board will be signed.

A report of inspection will be written stopping-wise in bound paged book kept for the purpose.

Q. 18. What precautions will be taken on detecting CO outside an isolation stopping during inspection of isolation stoppings of a sealed off caved panel? (2014)

Actions on detecting CO outside isolation stopping

While inspecting isolation stoppings of a sealed off caved panel, if the overman detects CO outside the isolation stopping, he shall :

- Check whether CO is coming out through plaster cracks or cracks in the surrounding strata needing re-plastering. If CO is coming out through sampling pipe, he shall close the valve properly & stop leakage. If CO is leaking out through water seal, he shall fill water in the water seal & stop leakage.
- Fence the approach to the stopping, withdraw persons from the return side and improve ventilation to dilute CO. If CO concentration is small, withdrawal may not be necessary.
- Check other stoppings also.
- Inform Assistant/Under Manager present underground and the Manager for investigation/arranging repair on war footing.
- Write the statutory report.

Occurrence of CO outside the isolation stopping may be an indication of leakage of fresh air into the sealed area and increasing fire activity. Apart from re-plastering, other actions will be :

- Verify CO ppm by using other CO detector.
- Draw air sample from the sealed off area & send for analysis quickly.
- Keep monitoring CO ppm at short intervals regularly.
- Inspect subsidence area over the panel to see whether there are any fresh cracks or pothole. If so, immediate action will be taken for blanketing.

Note : Presence of CO in large concentration outside the stopping can be an alarming situation in certain circumstances. In Anjan Hill mine, CO in large ppm was detected on 3rd May, 2012, and inspite of several actions taken , it led to an explosion on the 6th May.

Q. 19. What precautions should be taken on surface to prevent fires underground?

Surface precautions against fire

1.(a) Within 15m of the mine entrance (i) coal, shale or other carbonaceous matrial shall not be dumped, (ii) dead leaves or dry vegatation shall not be allowed to accumulate, (iii) oil, grease or other combustible material, other than that required within 24 hours shall not be stored, (iv) no inflammable material shall be stored.

(b) In opencast workings and within 15m of mine entrance no person shall be allowed to light a fire.

(c) Combustible material shall not be used in surface structures and supports within 10m of mine entrance.

2.(a) In opencast workings, and where possible in any ground broken by extraction of coal, wild plants, dead leaves and dry vegetation shall be cleared as often as may be necessary to prevent an outbreak of fire.

(b) No person shall be allowed to dump heated material or ash on any outcrop of coal, in o/c working or in any ground broken by extraction of coal.

3. Mouths of old shafts, inclines, adits not in use shall be kept sealed.

4. A competent person (mining sirdar/overman) shall inspect all shafts, inclines, adits, o/c workings and ground broken by extraction of coal to ensure that the above precautions are being taken.

Q. 20. Describe underground precautions to prevent occurrence of fire in the mine.

Underground precautions against fire

1.(a) Timber or other combustible material shall not be used in construction of shaft lining or any engine room.

(b) Wood cuttings shall not be left u.g.

(c) No air, grease, canvas or other inflammable material shall be stored in the mine except in a fireproof receptacle. Greasy or oily waste shall be regularly removed to surface.

(d) Brake lining of haulage, V-belts, brattice, air ducting and conveyor belting shall be of fire resistant type.

(e) Oil used in SDL, LHD, powered supports etc. shall be of fire resistant type.

(f) Oil filling of loco engine or other diesel equipment shall be done in oil filling station only.

2.(i) No person shall light a fire u.g. Persons entering the mine shall be searched properly to ensure that they do not take biri, cigarette, match sticks, lighter etc. with them to u.g.

(ii) In deg. II/III mines, no welding or gas cutting apparatus shall be used without permission from the RIM. In deg. I mine, such apparatus can be used with permission of the manager following his detailed instructions.

(iii) No person shall leave his safety lamp u.g. Safety lamps shall be properly maintained.

3. Electric cables shall be of adequate size. Trailing cables shall not be allowed to be damaged by mobile machinery. All cables shall be well supported and well protected. All electrical apparatus shall be properly maintained.

4. Conveyor belting shall not be allowed to scrape against wooden supports. Pulleys and friction rollers of haulage, and idlers/rollers of belt conveyors shall be kept cleaned and well maintained to prevent friction.

5. Proper provision shall be made to prevent outbreak of fire belowground or the spread of fire from any part of the mine or an adjoining mine, and adequate steps shall be taken to control or isolate any fire or heating that may occur.

6. Unused workings connected to surface through a walkable entrance shall be inspected by a competent person atleast once in 30 days for any signs of illicit distillation of liquor.

7. Coal shall be worked in panels. Depillaring shall not be commenced without making isolation and preparatory stoppings of the panel. Work of the panel shall be completed within incubation period and the panel shall be sealed as soon as extraction is over.

8. Subsidence cracks shall be sealed, the area shall be blankted by thick layer of matti consolidated from time to time.

9. Loose coal, shale shall not be allowed to accumulate in the mine. All fallen coal shall be removed. If that in not possible, such workings shall be sealed by isolation stoppings.

10. Sufficient material for dealing with the fire shall be kept available at suitable places in the mine for use. Sufficient number of persons shall be trained in use of this material.

11. To detect spontaneous heating in early stages, return air of every depillaring district–
    - shall be tested for CO atleast once in 7 days.
    - shall be completely analysed atleast once in 30 days to find CO produced/O_2 consumed ratio; in case of a steady rise, steps shall be taken to locate the fire and to deal with it.

12. To detect any danger of spontaneous heating, inspection shall be done as follows :
    - (i) inspection of depillaring district on every idle day,
    - (ii) inspection of unused workings once in 7 days.
    - (iii) inspection of isolation stoppings around depillaring area and those made to isolate unused mine workings once in 7 days.

Q. 21. Describe various methods of drawing samples of mine air.

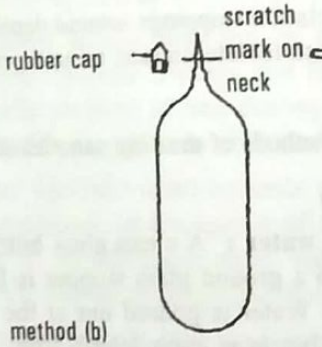
Methods of air sampling

(a) By displacement of water : A clean glass bottle of 100/200 ml capacity with a ground glass stopper is filled with water at the surface. Water is poured out at the sampling site u.g. keeping the bottle at arm's length from the body. Mine air takes the place of water. Stopper is fitted and secured in position by a rubber band. On the label of bottle, place, date, time of sampling and name of sampler are noted. This method is not suitable when CO_2 or nitrous gases are to be determined because they are dissolved by water being poured out, and some more by water left out in the bottle.

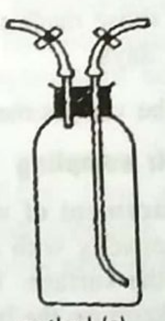
(b) By evacuated glass bulb or bottle : Evacuated glass bottle has a narrow neck which is sealed at the top. It is marked with a scratch mark for easy breaking. The bottle is held at the sampling point and the sealed end broken at the neck. Sample rushes in. Broken end is sealed by a tight fitting rubber cap. Evacuated glass bulbs may be used instead of glass bottles. On the label, site, date, time, place of sampling and name of the sampler are noted. Usual capacity of bottle or bulb is 250 to 300ml.

(c) **Air aspiration method :** Glass bottle used for this purpose has a cork fitted with 2 tubes– one reaching the bottle is for drawing out air from the bottle and the other short tube for entry of mine air. At sampling site air from the bottle is sucked out by a rubber bulb or a small hand-operated aspirator or pump.

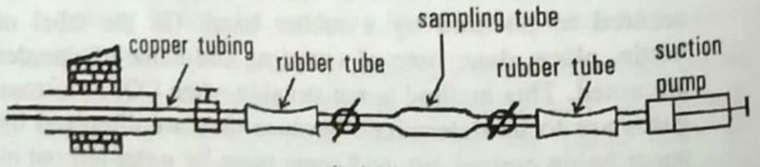
After enough mine air, say about 6 times the volume of sampling bottle has passed, mouths of both tubes are closed. While collecting the sample, the sampler should face the ventilating current and hold the sampling bottle at arm's length so that the sample is not affected by air exhaled by the sampler.



method (b)



method (c)



method (d)

(d) **Suction pump method** for drawing sample from behind the stopping :

In some fire stoppings, air sampling pipes are fitted. The sampling pipe has a narow copper tube (6mm dia). One end of glass sampling tube with stop cock at each end is connected by rubber tubing to the copper tube, and a suction pump is fitted at the other end. Suction pump is operated for some time to flush out the sampling pipe, and

the gas mixture to fill up the sample container. Both valves of sample container are closed. It is removed and place, date, time of sampling and name of the sampler are written on the label attached to it. To get representative sample, it should be drawn between 12 noon to 2P.M. when the atmospheric pressure is lowest in the day. Sample from a stopping should be drawn almost at the same time on every occasion for easy comparison.

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Chapter 19

DANGERS OF COAL DUST

Q. 1. What are the major dangers from coal dust?

Dangers from coal dust

1. Airborne respirable dust causes lung disease 'Pneumoconiosis'.
2. Coal dust accumulated in the mine (i.e.mine dust) can cause explosion.

Q. 2. What is the permissible limit of airborne respirable dust?

Permissible limit of respirable dust

At any working place in a mine, the concentration of airborne respirable dust (8 hours time weighted average)

- as measured by an approved dust sampler
- by a procedure specified by the DGMS,
- shall not exceed the following limit :
  - When working is wholly in a coal seam (or where free silica is less than 5%) : 3 milligram/m^3
  - at any other place : $\frac{15}{\text{free silica \%}}$ milligram/m^3

DGMS has approved gravimetric dust sampler type MRE 113A manufactured by Casella Ltd (U.K.) and has specified the procedure in Circular Technical 1/2004.

Concentration of dust, more than the above limit is considered harmful to health.

Q. 3. What is the defence mechanism of human body against deposition of air borne dust in the lungs?

What is the speciality of MRE 113A dust sampler (approved dust sampler)?

Defence mechanism of human body against dust

Large dust particles are filtered out by nasal hair. Particles

bigger than 10 micron size (1micron = 1/1000 mm) are caught by mucous membranes of the nasal cavity. Various percentages of different sizes less than 10 microns are again held back in the upper respiratory passages (naso pharynx, wind pipe, bronchii) and only a fraction reaches the lungs, for example 5 micron size reach only 50%, above 7.1 micron size zero%.

In 1952, the British Medical Research Council (BMRC) defined the percentages of dust particles sizewise that reach the lungs. This has been accepted internationally (after Johannesburg International Conference on Pneumoconiosis 1959) as the standard.

Speciality of MRE 113A dust sampler

This instrument simulates human body as far as dust deposition in lungs is concerned, and conforms to the BMRC standard of measurement of concentration of 'respirable dust'.

The instrument is hung at the place where dust concentration in air is to be measured. It draws air at a prescribed rate. The air first passes through a multiple channel part, called allutriator. These channels are designed to catch up dust particles of various sizes in percentages as are held back in the human body from reaching the lungs. The balance dust particles get deposited on its filter paper. By weighing the filter paper before and after the measurement, quantity of dust in milligram is found out, and from this, dust concentration in mg/m^3 of air is calculated.

Q. 4. What qualifications have been laid down for Airborne Dust Survey Incharge?

Describe briefly the procedure of airborne dust survey.

Airborne Dust Survey Incharge : Qualifications

1. Overman's certificate
2. At least 3 years experience as overman, including one year in the mine where he is engaged for airborne dust survey.
3. Training of the job.

Procedure of airborne dust survey

(a) *Frequency* : Normally once in 6 months.

If dust concentration exceeds 50% of the permissible limit, once in 3 months.

If it exceeds 75% of permissible limit, once a month.

(b) *Places of sampling in Bord & Pillar workings*

- 30m on intake side of first face and 30m on return side of last face of the district
- at every face
- loading, unloading, transfer points and near bunker chute.

(c) *Apparatus*

MRE 113A gravimetric dust sampler,

Sensitive balance for weighing the filter paper, and

Personal Dust Sampler.

(D) *Procedure*

(a) *Fixed point or static monitoring by MRE 113A*

1. The instrument shall be hung from roof, midway between the two sides, at nose level of worker.
2. In beginning of the shift pre-weighed filter paper shall be fitted, apparatus shall be started and time noted.
3. At end of the shift, time shall be noted, filter paper shall be withdrawn and weighed. Dust concentration in mg/m^3 shall be calculated.
4. Quantity of dust accumulated shall be converted to time-weighted average for 8 hours.

(b) *Portal to portal personal monitoring*

Personal dust sampler shall be fixed on body of the worker (whose concentration is thought to be representative), at beginning of the shift noting the time. At end of the shift, time shall be noted. Quantity of airborne dust shall be found by weighment of filter paper as above. Dust concentration shall be worked out and converted to 8 hourly weighted average.

Records shall be maintained

Coal sample shall be sent at least once to a laboratory for determination of free silica percentage.

Q. 5. Write a short note on pneumoconiosis. (1995)

Pneumoconiosis

This is a lung discase caused by inhalation of coal dust laden air over long periods of time (some years).

When a man breathes dusty air, coal dust particles coarser than 7 micron size (1micron=1/1000mm) are held up in the upper respiratory tract but various percentages of particles of other sizes reach the lung. Some of these cling to the lung surface forming nodules and render some area inactive. On repeated inhalation in such air over extended periods of time, more and more area is involved, causing shortness of breath and weakness. Gradually the man loses total energy to work. It renders the man prone to bronchitis and T.B.also.

So far no satisfactory cure of this disease could be found. Hence the only option is 'prevention'. As per the Mines Rules, mine workers are subjected to initial and periodic (5 yearly) medical examination, and the X-ray plates are checked to detect the disease in early stages. If necessary, his work-place is changed to limit the exposure to dust.

Under the Mines Act, pneumoconiosis is notified as an occupational disease of coal mines, for which the management has to pay compensation as per Workmen's Compensation Rules.

Note : The disease caused by inhalation of silica particles is known as Silicosis.

Q. 6. Write a short note on dust respirator. (1998)

Dust Respirator

1. When in any mining operation,
   - dust concentration cannot be kept within permissible limit, even inspite of all measures for reducing production and suppression of dust, and
   - dust exposure cannot be kept within safe limits, even by remote operation or job rotation,

- then workmen are to be provided with dust respirators, free of charge, as a secondary means of protection.

2. Dust respirators are also to be provided as a contingency measure, when dust prevention or suppression device of any equipment fails to operate, until the defect is rectified.
3. Dust respirators are cup shaped covers which cover the nose and mouth of the wearer. Air drawn is filtered before reaching the nose. They may be disposable type, made of filter grade fabrics (weighing less than 20g), or they may be replaceable filter cartridge type (weight various models 150 to 250g). Bureau of Indian Standards requires that dust respirators should have filtration efficiency of atleast 98%.
4. Filter is cleaned daily, or changed in case of disposable filters. Arrangements for cleaning, disinfecting and maintaining dust respirators are to be provided at the mine.
5. Dust respirators cause certain annoyance due to interference in speaking, difficulty in spitting and irritation to face, but they protect the health. They are needed in operations like drilling, dozing, chute operation, and operation of road headers. Workmen are to be encouraged and trained in use of dust respirators.

Q. 7. What are the major sources of dust in underground coal mines? What steps will you take to minimise generation of dust?

Sources of dust in u.g. mines

Major sources of dust in u.g. mines are operations of–

1. Coal cutting.
2. Drilling, including drilling for roof bolting. (10)
3. Blasting.
4. Loading of coal.
5. Transport of coal (including conveyor loading and transfer points, tub loading points, tippler, u.g. bunkers, skip loading points).
6. Movement of mobile machinery.
7. Coal handling/screening.

Steps to minimise generation of dust

1. *Coal cutting* : ensuring complete set of sharp picks in the cutting chain, correct tension of the chain; correct pressure on the chain while cutting; continuous spray of water; drawing the machine out as soon as the cut is completed.

   If a shearer or continuous miner is used, ensuring correct design, shape, arrangement and condition of picks, and correct cutting speed to minimise generation of small coal and dust; continuous application of water.
2. *Drilling* : ensuring use of sharp bits, correct pressure while drilling, cleaning the hole from time to time by frequently taking out the drill rod in motion.
3. *Blasting* : using correct pattern of holes, avoiding overcharging of holes to ensure production of large coal and minimum dust; use of water ampoules in stemming.
4. *Loading* : ensuring that baskets and coal tubs are not overloaded; not overloading conveyor loading points; dropping the coal slowly to avoid breakage and spillage. Avoiding spillage during loading by SDL or LHD.
5. *Transport* :
   - regular checking of tubs and taking leaky tubs out of circuit; proper laying and maintenance of tracks to prevent derailment of tubs and falling of coal from tubs.
   - regular removal of fallen coal from haulage roadways.
   - ensuring central running of belt conveyors, ensuring correct grading and alignment; proper tension in belt; minimum drop at conveyor loading and transfer points; regular cleaning of conveyors-specially at the drive and tail end drums; maintenance of idlers, rollers and side plates at loading and discharge points.
   - keeping some balance coal in ground bunkers to reduce fall of coal. Chutes, tipplers, skip loading/unloading points to be so controlled as to minimise generation of dust.
6. *Movement of machinery*
   - galleries from face to loading points shall be kept clear of fallen coal to prevent coal getting crushed by moving machinery.

- loading out fine coal washed down from faces, floor and sides within 60m from faces.

7. _Screening plant/Coal Handling Plant_

   Receiving hopper shall not be kept totally empty to reduce fall of coal; crusher shall be so set that it produces only minimum of small coal and dust; drop of coal in bunkers shall be minimised; conveyors, and conveyor loading, unloading and discharge points shall be well maintained to prevent spillage of coal.

Q. 8. (a) Who can be made a Dust Incharge?

(b) As a Dust Incharge, what planning and arrangements will you make to guard against the danger of coal dust?

(1986, 1990, 1997)

Qualifications of dust incharge

In coal mines, the work of cleaning of coal dust and treatment of roadways by stonedust or water is done under supervision of a competent person, designated as 'Dust Incharge'.

For appointment as dust incharge, the person should be a holder of manager's or overman's certificate or a degree or diploma in mining.

He is not given duties of sampling, nor is he given duties other than those of a Dust Incharge.

However, in mines producing less than 5000 tonnes of coal per month, Dust Incharge can act as Sampling Incharge also.

Planning and arrangements by Dust Incharge

1. **Dust Plan :** A dust plan shall be prepared to a scale of 1:2000, under guidance of the ventilation officer.

   It shall clearly show (by distinctive colours, code letters and numbers) the separate areas :

   (i) which are naturally wet and do not require treatment by water or stonedust.

   (ii) which require treatment with water, indicating layout of pipe lines.

   (iii) which require treatment with incombustible dust at intervals of 24 hours, 7 days, 14 days, 30 days or 3 months.

2. **Number plates**

   The above areas shall be demarcated in the workings by number plates.

3. **Cleaning, watering and dusting**

   (a) In parts which are to be treated with water, water sprinkling will be done in such manner and at such intervals that dust on floor, roof, sides and on supports always contains not less than 30% by weight of water, *in intimate mixture.*

   (b) Parts to be treated with incombustible dust shall first be cleaned, and then treated with incombustible dust in such manner and at such intervals as will ensure the dust on roof, floor, sides and any supports always contains-

   - not less than 75% incombustible matter if volatile matter of coal is less than 30%, and
   - not less than 85% incombustible matter if volatile matter of coal is more than 30%.

4. **Stone dust barriers**

   Stone dust barriers shall be examined at weekly intervals to check disperseability of stone dust and to ensure that any coal dust deposited over stone dust is removed. Dust shall be changed when it loses its disperseability. Barriers shall be shifted when required.

5. **Material, manpower and arrangements for wetting**

   (a) Adequate stock of stone dust shall be kept at suitable dry places in the mine. In case of shortage, ventilation officer shall be informed.

   (b) A sample of incombustible dust received shall be drawn and sent for analysis at intervals of 3months.

   (c) Arrangement shall be made for timely extension and maintenance of water pipe lines for spraying.

   (d) It shall also be seen that areas within 90m of the faces are sprayed with water immediately before firing shots and also at intervals during working hours.

6. **Record**

A daily record of areas cleaned of coal dust and of the areas treated with incombustible dust or with water, number of persons engaged and the amount of incombustible dust used shall be maintained in a bound-paged book kept for the purpose. Every entry shall be signed and put up to the ventilation officer or manager for counter signing.

Note : As per DGMS circular all mine plans, including Dust Plan, are now made to a scale of 1:2000.

Q. 9. (a) How does coal dust explosion occur in an underground mine?

(b) What are the factors affecting inflammability of coal dust?

(c) What measures are taken to prevent coal dust explosion?

Occurrence of coal dust explosion

When coal dust in the form of a dense cloud comes in contact with a source of heat of sufficient size (dimensions) and intensity (temperature) for a sufficient length of time, it can explode, and the explosion can travel in the mine over long distances.

Thus necessary circumstances are :

- fine coal dust should be raised in the air.
- it should be present as a thick cloud of dust (total quantity of coal dust may be small); the dense cloud may contain 30-40g of coal dust per m^3 of air.
- once explosion is initiated, as little as $1g/m^3$ is sufficient to extend the coal dust explosion to other parts of the mine. This much dust would make a layer on roof, floor and sides as thin as a sheet of paper and is present more or less everywhere in the mine.
- presence of sufficient O_2 in the air.

A combination of such circumstances can occur as follows :

1. **When methane gas explodes** : Explosion even of a small quantity of gas creates a pressure wave ahead of the flame, which raises into air the dust present in roadway, and it is exploded by the flame that follows it. Even small pockets of gas relatively of little danger in themselves, are potential sources of disaster.
2. **When a run away takes place** : A runaway of tubs in haulage roadway raises dust in the air. If just at that time, an electric cable laid in the haulage roadway is also damaged by a coal tub, resultant flash of fire can cause coal dust explosion. Such a disaster has occurred atleast in one country.
3. **When a 'blown out' shot occurs .**

Most of the explosions start as firedamp explosions but they change into coal dust explosion. Explosion of coal dust produces a large quantity of CO, it is very violent and spreads far and wide in the mine.

Inflammability of coal dust

Inflammability of coal dust depends on the following :

1. Volatile matter of coal : it increases the inflammability.
2. Size of dust : fine dust is more explosive.
3. Incombustible matter content : incombustible matter reduces inflammability.
4. Moisture content : it lowers the inflammability.
5. Concentration of firedamp : 1% firedamp is equivalent to $12g/m^3$ of coal dust.
6. Age of coal dust : old coal dust absorbs more oxygen and is more dangerous.

Measures to prevent coal dust explosion

1. Preventing production of coal dust in the mine.
2. Wetting the coal dust as it is formed, or sucking it out by dust extractor.
3. Face and roof, floor and sides upto 90m from the face to be washed and the accumulated coal dust to be taken out of the mine.
4. Removal of accumulated coal dust from the mine.
5. Wetting the 'naturally wet' places by water in such a

manner that coal dust contains at least 30% of water (by weight) in intimate mixture.

6. Stone dusting on the principle of little and often.
7. Taking all precautions to prevent firedamp explosion.
8. Not laying electric cable in a haulage roadway.
9. Preventing occurrence of blown-out shot.

Q. 10. As a Sampling Incharge how will you carry out work to keep a check on measures of dust control in a mine having 4 districts? (1986)

Dust sampling

1. Sampling plan

In every district return airways upto 200m from the last face, and all haulage, tramming and conveyor roadways shall be divided in sampling zones of 150m (or smaller). Each zone shall be divided in 3 sub-zones (or sections) a, b, c. Zones and sub-zones shall be marked on a plan of mine workings to a scale of 1:2000 to prepare a dust sampling plan.

2. Notice Boards

Zones and sub-zones shall be marked in u.g. workings by notice boards.

3. Sampling interval

Samples shall be collected from every zone once in 30 days. Samples shall be collected from sections a, b, or c in rotation such that during every period of 30days all samples are collected from the section a or section b or section c.

From all other roadways, samples shall be collected once in 3months.

Samples shall be collected in a systematic manner irrespective of cleaning and treating operations, but in no case within 24hours of cleaning, dusting of the zone.

Since there are 4 districts in the mine, work of one district shall be completed in one week.

4. Procedure of sampling

(a) From zones treated with incombustible dust, samples shall be collected by the method of 'strip sampling' (in strips of about 10cm wide, at uniform interval not exceeding 5m).

(b) From zones treated with water, samples shall be collected by the method of 'spot sampling'. A spot collection shall be made for every metre of length sampled, along a zig-zag path.

(c) Depth of sampling :

from roof & sides : maximum 5mm

from floor : maximum 10mm

(d) Each sample shall be thoroughly mixed and reduced to 30g by 'coning and quartering'. It shall be sealed in a water proof container labelled properly and sent to laboratory for testing.

5. Record

Within 7 days of sampling, results of sampling shall be recorded in Sampling Register and signed by Sampling Incharge. The record shall then be put up to the manager for counter-signature.

Q. 11. What is the purpose of stone dusting? State qualities of a good stonedust.

Purpose of stone dusting

Quantity of coal dust capable of spreading coal dust explosion in a mine is so small that even ofter cleaning the roadway thoroughly (so thoroughly that dust is not visible to the naked eye), the remaining minute quantity of dust can cause spread of the explosion. Incombustible dust is applied to render this left out coal dust harmless.

Incombustible dust—

(a) absorbs some of the heat that would otherwise ignite the coal dust or would assist propagation of flame through it, and

(b) screens the inflammable particles from radiant heat.

Stone dust is more effective in preventing the initiation of coal dust explosion than in preventing propagation when once started.

Desirable qualities of stone dust

Essential qualities

1. Stone dust should be very fine so that it rises and forms a cloud when disturbed.
2. It should be non-caking.
3. It should not contain more than 5% free silica, which is injurious to health.
4. It should be of light colour, so that coal dust is easily visible.

Other qualities

(a) If should be of low sp. gravity, as near to that of coal as possible.

(b) If should have high specific heat as to absorb heat without rise of temperature.

(c) If should be cheap, and easily available.

Q. 12. Write a short-note on :
(a) Stone dust barrier (1987, 1990, 1999, 2004)
(b) Dust Extractor (1993)

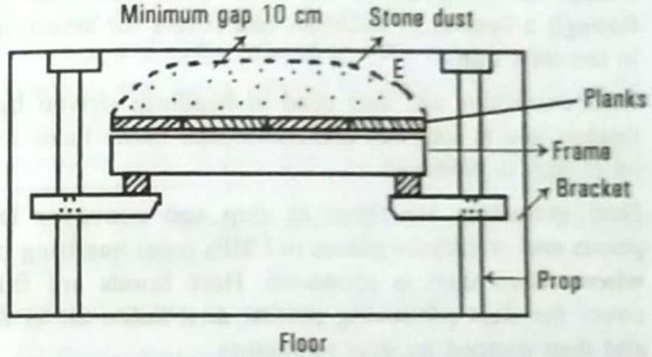
Stone dust barrier

1. Stone dust barriers are provided to prevent an explosion extending from one part of the mine to other.
2. *Where required* : They are required in
   - all seams of deg.II/III, and
   - development workings of deg.I seams in which there is likelihood of occurrence of inflammable gas in dangerous quantities.
3. *Principle* : Stone dust barriers are installed in all entries of the panel. In event of an explosion in the panel, the blast of air which precedes flame, causes the barrier to topple dispersing the dust in air to form a thick cloud of dust which smothers the flame and arrests its progress.

4. *Construction* : In India barriers of Polish design are used.

   A barrier consists of several shelves placed side by side. Each shelf consists of wooden planks placed side by side on a frame and loaded with stone dust. The frame is supported on brackets fixed on props erected on either side of roadway.

   In Bord & pillar workings, **heavy barriers** are installed.



Heavy barriers consist of *light shelves and heavy shelves.*

No. of heavy shelves = 2 × no. of light shelves

Dust loading : Light shelves 30kg/m of shelf length
Heavy shelves 60kg/m of shelf length

Total dust in one barrier = 390kg/m^2 of cross sectional area of gallery.

5. *Maintenance* : Each barrier is examined weekly to test dispersability of dust and to ensure that coal dust accumulated on the stone dust is removed. Barriers are shifted, as faces progress, to maintain specified distance from faces.
6. In certain circumstances barriers may fail. Hence they are to be taken as an 'additional measure' only –the normal measures of dust prevention, suppression, stone dusting and checking for gas must be continued to counter the danger of coal dust.

Dust Extractors

Dust extractor is used for collecting dust at the source and preventing it from getting airborne. It has many uses :

1. In opencast mines, the drill collar is enclosed by flaps. An exhaust fan sucks dusty air from the enclosure, routes it through a cyclone for separation of the dust and subsequent release into the atmosphere .
2. In stone drifts and in places where water for wet drilling is not available, dust extractors are used. A compressed-air ejector sucks dust from the hole through the drill steel and a duct in the body of the drill. Dust laden air passes through a system of cyclones and filters for arresting dust in the dust trap.
3. Dust extractors are also used in headings driven by road headers and at longwall and continuous miner faces where a lot of dust is produced.
4. Dust extractors are fitted at skip and conveyor loading points and at various places in CHPs (coal handling plants) where much dust is produced. Here hoods are fitted to cover the dust producing points, dust laden air is sucked and dust trapped by dust extractors.
5. Dust extractors are fitted to exhaust auxiliary fan before dusty air reaches the motor. Here it is caught in filters. Filters are cleaned from time to time.

Wherever dust extractors are used, they shall be examined at intervals of 7days and thoroughly examined once in 6 months to maintain their efficacy. Suitable records of tests shall be kept.

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Chapter 20

FENCINGS AND GATES

- Fencings and gates at mine outlets
- Fencings and gates related to mine workings
- Fencings and gates related to surface haulage roads and tramlines
- Common types of fencings (surface and underground)

Q. 1. State the statutory provisions regarding 'Fencings and gates at outlets'. (2000)

Fencings and gates at outlets (Reg.68)

1. (a) Every entrance to a mine from surface, and
   (b) tops
   - bottoms
   - sumps
   - entrances between top and bottom,

   of all working, ventilation and pumping shafts
   - shall be kept securely fenced.
2. - Every walkable entrance (incline, adit) from surface
     - shall be provided with a substantial gate.
   - The gate shall be kept closed and locked when there are no persons belowground.
   - Entrances not in use for entry or exit
     - shall be permanently closed in a manner to effectively prevent persons from entering.

Q. 2. Write the statutory provisions on Fencings and Gates. (2002, 2004)

Fencings and gates (Reg.112)

1.– Tops of OC workings,

- Portion of excavation within 15m of a public road or any building,
- Surface areas which have subsided, and
- Surface areas likely to subside,

shall be kept securely fenced.

2. Entrances to
   - shafts
   - staple pits
   - sumps
   - goaves, and
   - other dangerous places

   shall be provided with a fence, barrier or gate which will effectively prevent persons entering or falling therein.
3. Where a shaft, staple pit or a gallery steeper than 30° (from the horizontal)
   - leads directly into a working place or roadway,

   the working place or roadway and workings on its dipside shall be securely guarded/protected.
4. Entrances from an u.g. roadway
   - to parts not being worked or used,

   shall be provided with fence or gate to prevent inadvertent entry.
5. Shafts and OC workings.
   - temporarily or permanently out of use, and
   - any dangerous place in or about an excavation,

   shall be completely filled in or kept securely fenced.

   Any disused trench, pit or excavation considered dangerous by Regional Inspector shall also be filled up.
6. Before a mine is abandoned or its working discontinued,
   - the top or entrance of every shaft, incline or other mine opening,

   shall be fenced by a permanent structure which can prevent persons falling into or entering the mine.

Q. 3. Describe statutory provisions on 'Fencings and gates' to prevent danger from a 'haulage road or tramline on surface.'

Fencings and gates for haulage roads and tramlines (Reg.97)

1. Where any haulage road or tramline passes over a public road,
   - suitable gate shall be provided to prevent danger to public from moving tubs or locomotive.

   The gate shall be fitted with a danger signal,

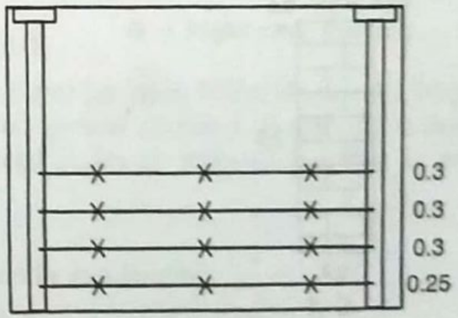
   and when natural light is insufficient, also with a warning lamp.
2. Where occupied buildings are situated within 15m of any haulage road or tramline,
   - a substantial fence shall be provided between such building and the haulage road or tramline.

Q. 4. Describe briefly with sketches two main types of fencings used in a mine belowground.

Fencings for underground

Two main types of fencings used belowground are U-1 and U-2.

U-1 Wire ropes (or rope strand, barbed wires or rollas) nailed to vertical props set flush on sides of the gallery. Gap of bottom most member from floor 0.25m, between other members 0.3m, top not less than one metre from ground.

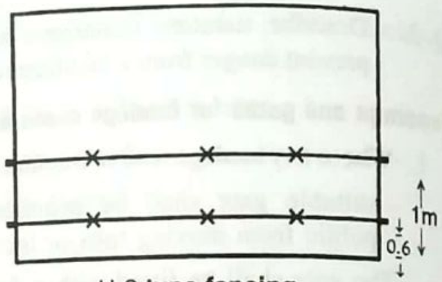


U-1 type fencing

U–1 fence is used at :

- Goaf edges
- Areas of roof fall
- Place of misfire
- Place of accumulation of gas
- Site of accident.

U-2 It consists of two wire ropes (or rope strands, barbed wires or wooden rollas) fixed with cement in sides of pillars across the gallery at a height of about 0.6m and 1.0m respectively.



U-2 **type fencing**

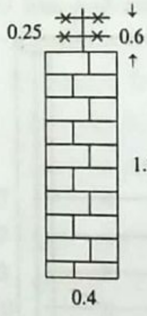
U-2 is used

- at entries to disused galleries.

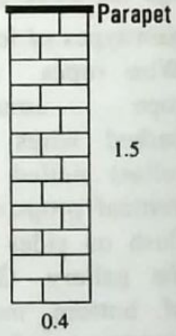
Q. 5. Giving sketches describe two types of brick fencings constructed on mine surface. Indicate places where they are used.

Surface fencings S-1 and S-2

Two main types of fencings used on surface are the S-1 and S-2 types.



S -1



S - 2

S-1 : 0.4m thick brickwall,1.2m high with a barbed wire fence not less than 0.6m on top (wires not more than 0.25m apart)

S-1 is used on top of sand bunkers, water tanks etc.

S-2 : 0.4m thick brickwall, 1.5m high with a parapet top.

or

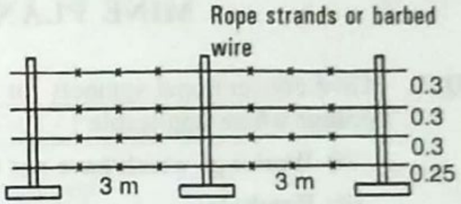
0.75m thick stone wall 1.5m high

S-2 is used at closed shafts, inclines, O/C workings and around subsidence areas.

Q. 6. How is movable fencing made and where is it used?

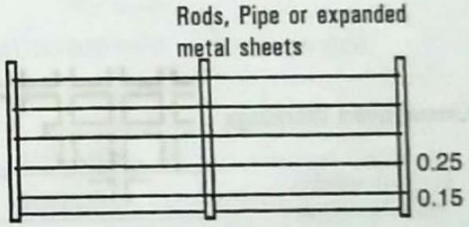
Movable fencing (S-3)

S-3: Wire ropes (or rope strands or barbed wire) supported by movable post-stands (wooden, iron or concrete) standing at 3m intervals. Gap of bottom most member from ground not more than 0.25m, between any two other members not more than 0.3m, topmost not less than 1.0m from ground.



S-3 Movable Fencing

S-3 is used in opencast workings. These days light section angle iron posts fixed in ground are used instead of mobile posts.



G -1 Rigid steel Fencing

Rigid steel fencing (G-1)

G-1 : Angle iron (5 × 5 cm) [or pipes 7.5cm dia or rails 10kg/m or concrete posts] vertical members. Horizontal members of expanded metal sheets or pipes (2.5cm dia) or solid rods (2cm dia).

G—1 is used at :

- top of shaft, inset or mid landing
- top of staple pit
- around large machine parts

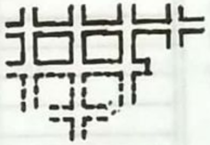
There are in all 10 types of fencings : surface fencings S-1, S-2, S-3, underground fencings U-1, U-2, and General fencings G-1 to G5. General fencings may be used both on surface and in workings belowground. The above information should be sufficient for the reader.

Chapter 21

MINE PLANS

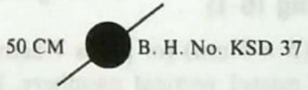
Q. 1. Give conventional symbols for the following, indicating colour where applicable :
- (i) Workings which have not been surveyed
- (ii) Borehole
- (iii) Water dam
- (iv) Dust barrier (1995)

Unsurveyed Workings

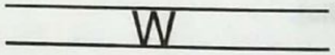


Workings shown by dotted lines are not surveyed and their extent is not correctly known

Bore hole

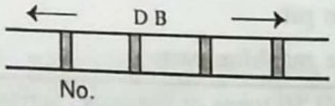


Water dam



In Red

Stone Dust Barrier



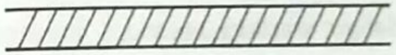
In Red

Q. 2. Illustrate with neat sketches appropriate symbols for the following, mention colour of the symbol where applicable–
- a. underground coal barrier
- b. drift

- c. subsidence
- d. direction of air current
- e. ventilation stopping
- f. u.g.first aid station. (1999)

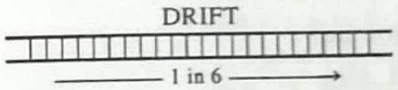
Symbols for mine plans

u.g.coal barrier



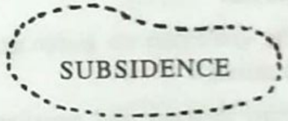
In Green

Drift



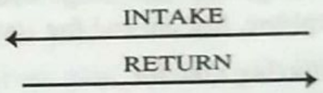
In Burnt sienna showing gradient in Black

Subsidence



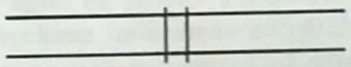
In Red

Direction of air current



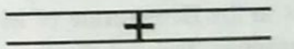
Intake in blue return in Red

Ventilation stopping



In Red

u.g. first aid station



Thick cross in Red

Q. 3. (a) Write a detailed note on overman's hand plan.

(b) What is offset plan of a depillaring district?

Overman's Hand Plan

An overman on duty has to carry with him Overman's Handplan made by the surveyor to a scale of 1/2000 on a tracing cloth and signed by him. It is a true copy of a part of the underground plan of the mine giving names of districts and galleries etc, and showing the following special features :

1. Parts of mine under the charge of the overman.
2. Projection lines of workings, with size of pillars, galleries (and the point where size will change).

3. Any special conditions imposed by DGMS.
4. Sequence of extraction of pillars in depillaring districts.
5. Proposed sites of isolation stoppings and air crossings.
6. Position of known or apprehended dangers, such as
   - faults, dykes, boreholes
   - restricted workings
   - water danger warning lines
   - goaves
   - subsidence area
   - staple pit, drift
   - u.g.coal barrier

   (They help the overman to keep an eye on changes in working conditions)
7. Intake and return airways and ventilation stoppings, doors, aircrossings; haulage and travelling roadways; emergency exit routes; telephone, first aid and fire stations.

Offset plan of depillaring district

This is a plan of depillaring district on large scale (such as 1/500) which is made by surveyor after conducting offset survey of all pillars and galleries to show correct size and shape of each pillar. It is a plan sent to the Directorate of Mine Safety with the application for permission for depillaring. The sequence in which pillars will be extracted is marked on the plan. A copy of the approved plan is carried by Mining Sirdar/Overman.

By seeing this plan, decision is taken for each pillar as to in how many parts it will be split, the position of split gallery and the manner of extraction. As each slice is extracted, the Mining Sirdar/Overman keeps on marking the plan so that position of goaf edge cogs, and other supports can be decided. Areas of extending goaf and stowed areas are also kept marked by the Mining Sirdar/Overman.

The plan is made on tracing cloth and renewed from time to time.

Q. 4. Write statutory provisions on the following :
Types of plans to be kept and maintained at the mine. (2002)

Types of plans

1. The owner, agent or manager of every mine shall keep and maintain the following plans and sections :

   (a) Surface plan

   (b) Underground plan– separate for each seam or section
   – a combined u.g. plan of seams or sections which are within 9m of each other. Every seam or section shall be shown by a different colour.

   (c) Vertical projection– in case dip is more than 30°. It shall also be separate for each seam or section.

   (d) Ventilation plan– separate for each seam or section.

   (e) Geological plan

   (f) Joint survey plan

   (g) Water danger plan

   (h) Any other plan as desired by Regional Inspector

2.(a) Surface and u.g plans shall show surface contours at 5 m intervals.

(b) Underground plan shall show spot levels
   – along haulage roadways, at every junction,
   – at the end of headings which have been discontiuned temporarily or permanently.

(c) Where two drifts in stone or two galleries in coal pass over one another, this shall be clearly indicated on the plan.

(d) A permanent bench-mark shall be established on the surface, and all levels taken above and belowground shall be referred to such bench mark.

3.(a) Surface and u.g.plans shall show the mine boundary.

(b) u.g.plan shall show all surface and underground features upto 60m on either side of the mine boundary.

4. All plans shall be maintained updated and kept readily available.
5. Regional Inspector may require showing any additional information on the plan. He may ask for specified plans, sections or tracings to be submitted to him, or to show on any plan or section the then position of the mine workings.

Q. 5. Write short notes on :

Surface plan (1992)
Ventilation plan
Geological plan

Surface plan (scale 1 : 2000)

Surface plan shows mine boundary and all surface features within it, such as–

- river, water course, reservoir, tank
- road, railway, tramline; telephone, telegraph or power transmission line; water main, gas pipe line.
- mine openings (boreholes, shafts, inclines, opencast workings, subsidence areas)
- buildings and surface structures.

It also shows surface contours (at 5m intervals), permanent bench mark and survey base line.

Ventilation plan (scale 1:2000)

Ventilation plan is one of the main plans to be kept at every underground mine. It is a plan of underground workings (with goaf, fault/dykes) showing ventilation system of the mine including direction of air, air measurement stations and control devices such as stoppings, air crossings, doors, regulators, booster and auxiliary fan.

It also shows-

- fire stoppings, fire station
- water dams; pumping, telephone and first aid stations; stone dust barries
- haulage and travelling roadways.

This plan helps in proper maintenance of ventilation system of the mine.

Geological plan (scale 1 : 5000)

It is a plan showing geological structure of mine area, namely surface contours; coal seam outcrops/incrops; extent of different rock types; faults, folds, dykes, dip; bore holes and bore hole sections) and mine openings (shafts, inclines etc).

Mine boundary, main survey and levelling stations are also marked on it.

Q. 6. Write a short note on 'underground plan'.

Underground plan (scale 1 : 2000)

This is the main plan of the mine which is made one for each seam or section. If two seams or sections are within 9m of each other, a combined plan is also prepared in which each seam or section is shown by a different colour.

Underground plan shows :

(i) all underground workings (including discontinued workings), and u.g. workings, goaves and surface features upto 60m outside the mine boundary.
(ii) all mine openings (boreholes, shafts with depth, inclines, drifts, staple pits).
(iii) Important u.g. features such as fire stoppings, waterdams, pumping stations and haulage roads.
(iv) every important surface feature within the boundaries, such as railway, road, river, stream, water-course, tank, reservoir, opencast working and buildings lying within 200m of any part of the workings.
(v) general direction and rate of dip of the strata.
(vi) sections showing variation in thickness of seam or its character, and showing the working section, and section of the strata sunk or driven through in the mine or proved by bore holes.
(vii) position of every roll, washout, dyke, fault (with amount and direction of throw).

(viii) an abstract of all statutory restrictions imposed by DGMS.

(ix) one or more vertical sections if seam has an average inclination more than 30°.

(x) spot levels of the floor of the workings–

- along haulage roadway at every junction
- at the end of headings discontinued temporarily or permanently.

Q. 7. Enumerate the main mine plans and other plans kept at the mine.

Main plans kept at the mine

1. Surface plan
2. Underground plan
3. Ventilation plan
4. Geological plan
5. Joint survey plan
6. Water danger plan

Other plans

7. Stone dusting plan
8. Dust sampling plan
9. Fire fighting plan
10. Overman's handplan
11. Offset plan of depillaring
12. Rescue plan
13. Electrical plan
14. Abandoned mine plan
15. Accident plan
16. Subsidence plan
17. Manpower distribution plan

Q. 8. What is water danger plan? (2001)

Note : See chapter on 'inundation of mine workings'.

Q. 9. What is contour line?

Contour line

Contour line is a line on the plan showing surface points of the same elevation, for example, a 210m contour line on the plan will show all surface points which are 210m above the surface bench mark. Contours show relief of the ground. They are drawn on surface and underground plans at 5m intervals.

Q. 10. How will you show the following on your handplan as per statute (mention colour where applicable)

(a) staple pit

(b) brattice

(c) ventilation door

(d) goaf

(e) subsidence

(f) explosion-proof stopping

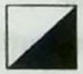
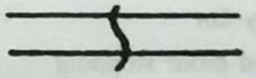
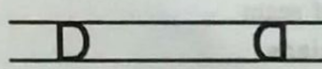
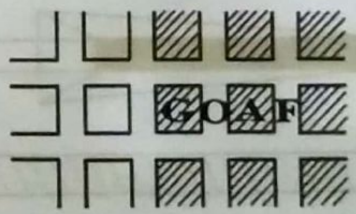
(g) regulator

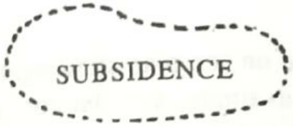
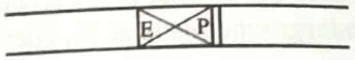
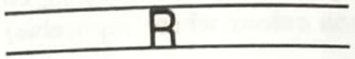
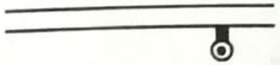
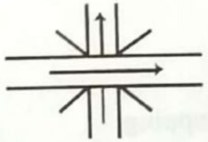
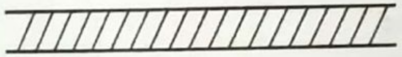
(h) telephone

(i) air crossing

(j) underground coal barrier **(2002)**

Symbols for overman's handplan

Staple pit		**In Red (state distances up and down to all insets)**
Brattice		**In Red**
Ventilation door		**In Red**
Goaf		**In Green**

Subsidence		In Red
Explosion-proof stopping		In Red
Regulator		In Red
Telephone		In Red
Air crossing		
u.g.coal barrier		in green

Q. 11. How will you show the following on a mine plan (give sketch mentioning colour)–

(a) Abandoned incline

(b) Underground coal barrier

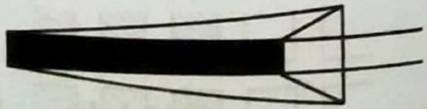
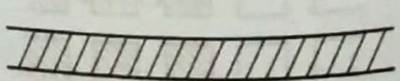
(c) Ventilation door

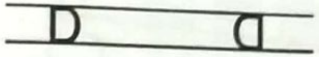
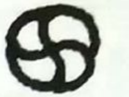
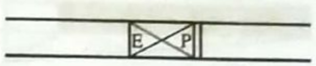
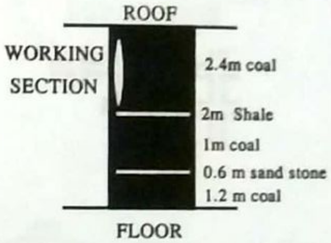
(d) Auxiliary fan

(e) Explosion-proof stopping

(f) Section of seam (2004)

Symbols for mine plans

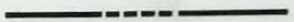
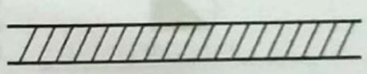
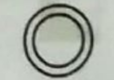
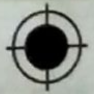
Abandoned incline		
u.g.coal barrier		In green

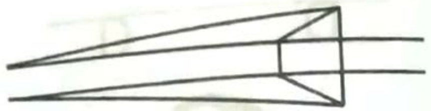
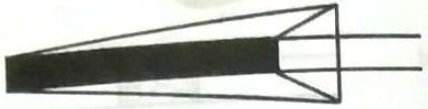
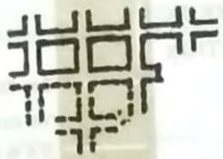
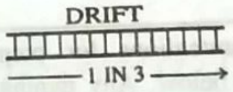
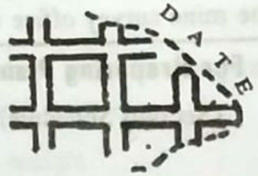
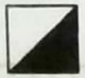
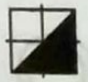
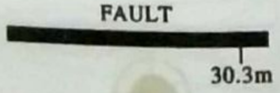
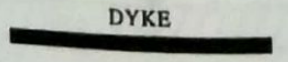
Ventilation door		In Red
Auxiliary fan		In Red
Explosion proof stopping		In Red
Section of seam	 ROOF WORKING SECTION 2.4m coal 2m Shale 1m coal 0.6 m sand stone 1.2 m coal FLOOR	In colour of the plan

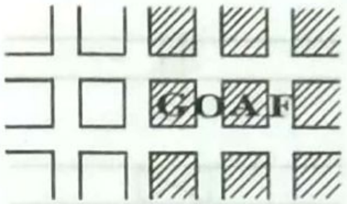
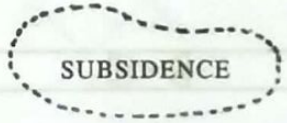
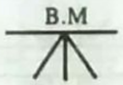
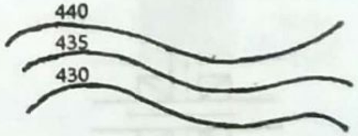
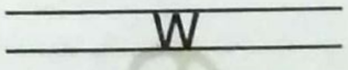
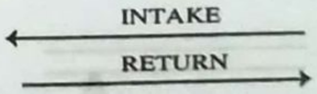
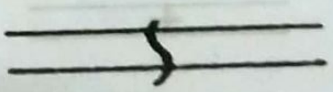
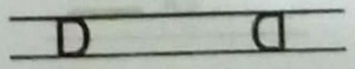
All prescribed conventions for preparing plans and sections are given below. Any mining official must be thoroughly acquainted with these symbols. A study of some plans at the mine survey office will be helpful.

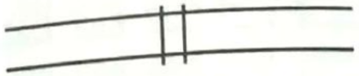
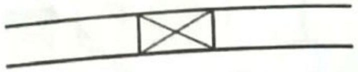
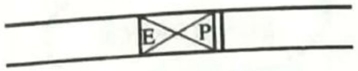
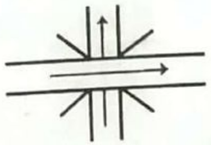
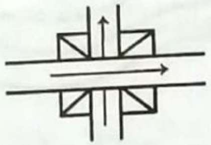
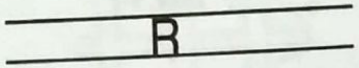
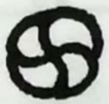
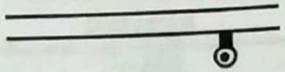
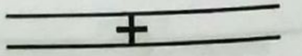
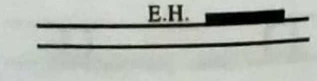
Conventions For Preparing Plans And Sections

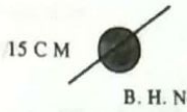
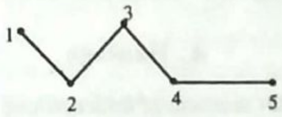
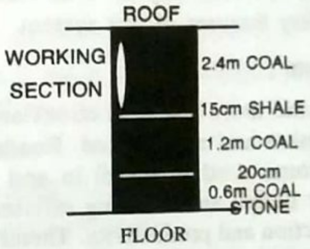
(Second Schedule)

Boundary of Leasehold		In Red
Underground Coal Barrier		In Green
Shaft		
Abandoned Shaft		

Incline		
Abandoned Incline		
Pillars and galleries		Workings shown by dotted lines are not surveyed and their extent is not correctly known
Drift		In Burnt sienna showing gradient in Black
Quarterly Survey Line		
Staple Shaft		In Red; should state distances up and down to all insets
Abandoned Staple Shaft		In Red
Fault		In Red showing the amount and direction of throw
Dyke or Other Intrusion		In Green

Goaf		In Red
Subsidence	 SUBSIDENCE	In Red
Bench Mark		
Surface Contour		In Burnt Sienna
Underground Spot Level	+ 104.94	In Blue
Water Dam		In Red
Direction of Air Current	 INTAKE RETURN	Intake in Blue Return Red
Brattice		In Red
Doors		In Red

Brick/Stone or Concrete Ventilation Stopping		In Red
Fire Dam, Seal or Stopping		In Red
Explosion proof stopping		In Red
Air Crossing		
Explosion Proof Air Crossing		
Regulator		In Red
Auxiliary Fan		In Red
Telephone		In Red
Underground First-Aid Station		Thick cross in Red
Engine House or Room		

Bore Hole	 15 C M B. H. No. 37	Show serial number and diameter
Survey Lines & Stations		
Section of Seam	 ROOF WORKING SECTION 2.4m COAL 15cm SHALE 1.2m COAL 20cm 0.6m COAL STONE FLOOR	

Chapter 22

HAULAGE, WINDING, PUMPING AND USE OF ELECTRICITY

A. Haulage

Q. 1. In the present scenario of underground coal mines, describe importance and necessity of 'man riding system'. Give briefly safety features of this system. (2009)

Man Riding System

These days, more and more u.g. coal mines are becoming deep, high output, extensive and mechanised. Roads being steep and long, workers become tired in travel in and out of the mine, which affects their health and working efficiency. Time loss in travel affects production and productivity. Therefore, importance of man-riding systems has increased.

Man-riding system :

- Reduces fatigue, prevents deterioration of heath of workers
- Increases production and productivity
- Reduces accidents
- Improves morale of workforce.

Man-riding systems have been installed in almost all u.g. mines of Singareni. CIL has introduced man-riding systems in some mines and decided to provide systems in all other mines,

- Where seam gradient is more than 1 in 4 and travelling distance exceeds 1.5km
- Where seam gradient is less than 1 in 4, but travelling distance is more than 3km
- Where highly capital intensive equipment like continuous miners or longwall machinery are used.

Man-riding systems : Types

In Indian u.g. mines, 4 types of man-riding systems are used :

1. Locomotive system

2. Direct haulage system
3. Chair lift system
4. Telfer system

Safety features of chairlift system - the most common system—are given below. It is a simple system consisting of an endless rope running slowly along roof of travelling roadway. Chair lifts are (hangers made of pipes with a chair) stacked at either end of journey and at regular stopping/riding stations. Anyone who wants to travel, takes a chair lift, hangs it on travelling rope and sits on the chair. When he reaches alighting station, he gets down from chair, removes the chair lift from the rope and puts it in the stack.

Safety features of chair lift system

1. The system is made as per DGMS specifications and used with DGMS permission.
2. Safety devices :
   (a) Rope speed indicator
   (b) Over speed preventor
   (c) Rope backward movement preventor
   (d) Rope over stretch limit switch
   (e) Efficient brake on engine
   (f) Pull cord in the roadway to stop the system from any point
   (g) Over travel limit switch at either end of the journey
3. Factor of safety of rope 10 (like winding). Rope speed not exceeding 0.8m/s.
4. Signalling system.
5. Roadway :

(a) Gradient maximum 1 in 4, properly supported, white-washed and lighted.

(b) Clearances :	Top of chair to floor	1.0m
	Roadway side and chair	0.8m
	Between 2 consecutive chairs	1.2m

6. Suitable well- lighted stations at either end of journey and at intermediate stopping places.
7. Manager's scheme for installation, operation, maintenance, testing and repair.

Note : Telfer system is also quite simple and its safety features are similar to those of the chair lift system. It consists of an endless rope running along roof of the roadway. Each person travelling has a hook attached to his cap lamp belt, the other end of which can be put on or off the rope to get assistance of rope in travelling. The system is used for uphill travel only.

Q. 2 Enumerate the main causes of accidents due to haulage.

Main causes of haulage accidents

Almost 15% of fatal accidents in u.g. mines are due to haulage. The main causes are:

1. Runaway of tubs.
2. Derailment of tubs.
3. Non-provision or non-functioning of stop block, runaway switch, drag or other safety devices.
4. Badly laid curves requiring the trammer to stand on tub buffer to guide it across the curve.
5. Riding on tub buffers.
6. Failure of persons to take proper shelter in manholes, or manholes not clean and free from obstruction.
7. Uncontrolled movement of tubs.
8. Head of trammer getting crushed between tubs while coupling/un-coupling.
9. Substandard sprags or shortage of sprags.
10. Travelling along haulage roadways.
11. Loaders crowding at junctions of haulage roadways and tramming levels to stake the first claim on empty tubs.

Q. 3. What precautions will you take to prevent derailment of tubs at curves? (2001)

Measures to prevent derailment of tubs at curves

1. Track at curves should be properly laid with,
    - Large radius
    - Outer rail super elevated, or check rail along full length of inside rail
    - Gauge wider by 6mm to prevent wheel flanges pressing on the rails

    - Rail joints staggered and gauge ties on each side of rail joint
    - Track well packed
    - Adequate number of pulleys securely installed to guide the rope.
2. Position indicator on the haulage should have markings of curves, to enable haulage *khalasi* to reduce tub speed at the curve.
3. Track at the curve should be especially well maintained.

Q. 4. What precautions should be taken in loading of tubs?

1. Before commencing loading, tubs should be kept spraged.
2. Loading of tubs on gradient should be avoided, and if it cannot be avoided, tubs should be loaded one at a time starting from the dip end.
3. Tubs should not be overloaded. Big lumps should not be placed on top of loaded tubs.

Q. 5. (a) What steps should be taken to prevent accidents due to :

- Runaway of tubs
- Derailment/re-railment of tubs.

(b) How to prevent accidents during coupling/un-coupling of tubs?

Prevention of accidents due to runaway of tubs

1. Track to be properly laid and well maintained.
2. Rope to be properly maintained.
3. Only approved types of rope cappel, couplings and draw bars to be used. These to be inspected regularly and worn outs to be replaced timely.
4. Tubs in a set not to exceed the number fixed by the manager.
5. Sufficient number of friction rollers and pulleys to be installed, regularly cleaned and oiled.
6. Upcoming set of tubs in direct haulage to have a drag attached to the rear axle of the last tub. In an endless haulage, back-catches to be provided.
7. Jazz rails to be provided at specified places.
8. Sprags of proper design and adequate strength to be kept available in sufficient number.

9. Manholes to be made on one side of track at prescribed intervals, and to be kept whitewashed and clear of obstructions.
10. Travelling along haulage roads to be strictly prohibited.

Prevention of accidents due to derailment and during re-railment of tubs

1. Tracks shall be well laid and properly packed. Rotten sleepers shall be changed well in time. Gauge of the track shall be checked from time to time. Curves shall be of a large diameter, outer rail shall be super-elevated or check rail provided all along the inner rail of the curve. If there is water in haulage road, drain shall be provided.
2. Tubs shall be examined and maintained regularly. Defective tubs shall be removed from the circuit promptly.
3. Re-railers shall be installed at every 250m.
4. Trammers shall be trained in correct method of re-railment. When tubs are being re-railed, there shall be no other persons present nearby.
5. Tubs standing on a track steeper than 1 in 20 shall be effectively blocked or chained, unless held effectively by haulage brake.
6. There shall be no sudden changes of gradient. Haulage *khalasi* shall run the haulage evenly without jerks. Position of jazz rails and curves shall be marked on the position indicator to enable him to reduce speed at those points.

Prevention of accidents during coupling/un-coupling of tubs

1. No coupling/un-coupling of tubs in motion or on a gradient.
2. Adequate working space at coupling/un-coupling places—atleast 1m between tubs and sides and also between two tracks.
3. Coupling/un-coupling points to be well lighted.
4. Tub buffers to be kept well maintained.
5. *Loose men*/trammers to be trained to keep head clear of tubs during coupling/un-coupling and to use a distance block.
6. Gradient of load track from the level roadway to be slightly in favour of the loads so that they negotiate the curve to the dip side easily.

Q. 6. Enumerate safety devices provided in an underground haulage roadway.

Safety devices in u.g. haulage roadway

1. Stop block	(at top of inclined plane to arrest tubs from running out of control).
2. Run-away switch	(below the first stop block at a distance greater than the length of a set of tubs, but not greater than length of set + 10m); run-away switch shall preferably be inter-coupled with the stop block.
3. Drag or backstay	(behind an ascending tub or set of tubs to prevent tubs running back).
4. Jazz rail	(to prevent forward run away of tubs)
5. Tub Re-railers	(at intervals of not more than 250m to lift derailed tubs)
6. Signalling system	(such that from any part of the haulage road signal can be transmitted to the driver).
7. Telephone	(If end of haulage roadway is over 600m from the mine entry).
8. Manholes	(at 10m intervals on one side of the haulage roadway; at 20m intervals if gradient is flatter than 1 in 6).
9. Buffer	(where any roadway or face is in direct line of the haulage track).
10. Sprags	(in adequate number at every place where they are needed).
11. Stop block	(near entrance to every branch roadway and every tramming roadway branching off the main haulage roadway).

12. Lighting	(At regular coupling/uncoupling points)
13. Notice of maximum no. of tubs in a set	(at the top and at regular stopping places of haulage roadway).
14. Copy of code of signals	(in haulage engine room and at all regular stopping places along the roadway).
15. A lever	(to put haulage rope on friction rollers)
16. Protection from tubs moving out of control	(for persons using telephone or operating signal or safety device.)

Note : If in the question length of haulage roadway and gradient are given, then also the question will be answered as above but special mention shall be made of rerailers at every 250m and manholes at intervals of 10 or 20m according to the gradient given.

Q. 7. What are the statutory provisions for haulage roadways in an underground mine? (2005)

Statutory provisions for haulage roadways

(a) Every haulage roadway shall be of

- adequate dimensions
- as straight as possible
- of regular gradient.

(b) Tracks shall be

- properly laid
- with rails of adequate section
- pulleys, sheaves, rollers securely fixed.

No person shall guide or adjust a moving rope on to drum, pulley, roller etc.

(c) Safety devices to be provided and maintained :

1. **stop block** at top of every inclined plane, to prevent tubs running out of control.
2. **run away switch** below the stopblock, at a distance greater than length of set of tubs, but not exceeding it by more than 10m.

3. **back stay or drag** behind ascending train in direct haulage, and catches at suitable intervals in endless haulage.
4. **safety hooks, jazz rails** etc. to prevent forward run-away of tubs.
5. **tub re-railers** at not more than 250m intervals.

   If a tub is re-railed manually, it shall first be detached from the rope or the engine shall be kept stopped.
6. **signalling system** for giving signals from every stopping place on the roadway to engine room.

   Signal wires shall be supported on insulators; contact makers shall be such as to prevent accidental closing.
   - Signals shall be given by authorised persons only.
7. **printed copy of code of signals** shall be posted in the haulage engine room and at all regular stopping places.
8. **telephone** between end of haulage roadway and bottom and top of shaft/incline.
   - telephone and signal wires shall be kept away from power cables.
   - in deg. 2 & 3 seams, signalling and telephone system shall be intrinsically safe.
9. **buffer** or other effective provision where a roadway is in direct line of a haulage track or face.
10. **manholes**
    - at 10m intervals (at 20m intervals if gradient is less than 1 in 6)
    - On one side of the roadway, as far as possible.
    - Height : not less than 1.8m or height of the roadway, if it is less than 1.8 m.
    - Depth : not less than 1.2m.
    - Width : not less than 0.75m and not more than 1m.
    - White washed inside, and atleast 0.3m around the aperture.
    - kept clean and free of obstruction.
11. **stop block** at entrance of every tramming roadway branching off the haulage roadway, and every track which slopes towards a shaft.

12. **clear space** of 1m, at all places, where tubs are coupled/uncoupled,
    - between the tubs and one side of roadway.
    - between 2 adjacent tracks.
13. **protection** from danger from moving tubs where telephone receivers are installed or where signais or safety devices are regularly operated.
14. **No travelling** along haulage roadways. When rope is in motion, persons in the haulage roadway shall take shelter in manholes (except in endless rope haulage).

Q. 8. Write a short note on haulage and travelling roadways. (2014)

Haulage roadways

1. Should be of adequate dimensions, straight, of regular gradient.
2. Have tracks well laid with rails of adequate size; friction rollers, pulleys/sheaves securely fixed.
3. Provided with necessary safety devices: Stop block at top of inclined plane, runaway switch below it, jazz rails to prevent forward runaway, drag behind ascending set of tubs to prevent backward runaway, re-railers, stop blocks at entrances to tramming roadway branches, buffer at lowest end. Signal wires on one side. Manholes on one side - of proper size, at 10 m intervals (upto 20 m intervals if gradient in less than 1 in 6), clear of obstruction, white washed. Adequate no. of strong sprags; notice of signalling code and maximum no. of tubs to be attached in a set; telephones if length exceeds 600 m.
4. Places where tubs are coupled/uncoupled, should have at least 1 m clearance between tubs & one side; 1 m also between tracks. These places should be white washed & lighted.
5. These should be inspected once every 7 days by overman.

Travelling roadways

1. Should be not circuitous, but as short as possible, in intake airways, well drained, white washed and well lighted, with direction marks.

2. Height not less than 1.8 m; provided with steps if gradient exceeds 30°, also with hand rails if gradient exceeds 45°, further with platforms at 10 m intervals if gradient exceeds 60°.
3. Provided with cross-over/cross-under where it crosses a haulage track.
4. Except when travel along haulage roadway is necessary for inspection or repair, all persons, including officials, should travel by travelling roadway only.
5. Travelling roadways are inspected once in 7 days by overman and kept tidy & well maintained.

Q. 9. What precautions should be taken if part of the haulage roadway is to be used for travelling? (1992)

Using part of haulage roadway as travelling roadway

Where a separate travelling roadway cannot be provided and persons have to travel along a part of the haulage roadway, the following precautions will be taken–

1. An exemption will be obtained from Regional Inspector.
2. Two-way signalling will be provided between the two ends.
3. Travelling shall be only during specific periods fixed by the manager. Notices showing these periods shall be posted at top and bottom, and at regular stopping places along the haulage roadway.
4. If it is absolutely necessary for any person to travel outside the aforesaid periods, he shall give special signal to the haulage engineman.
5. Inexperienced persons shall be accompanied by experienced persons.

Q. 10. State the rules concerning manholes on haulage roadways.

Rules for manholes

1. Manholes shall be provided
   - all along the haulage roadway
   - not more than 10m apart, or if gradient is flatter than 1 in 6, not more than 20m apart.

– on one side of the roadway (as far as possible)

2. Size : Height at least 1.8m or height of the gallery
   Depth at least 1.2m
   Width at least 0.75m but not more than 1m
3. Manholes shall be kept
   - clean,
   - clear of obstruction,
   - white washed inside and 0.3m outside around the aperture.
4. Whenever haulage rope is in motion, all persons on the haulage roadway (other than endless haulage roadway) shall take shelter in manholes.

Q. 11. What precautions should be taken by a trammer in hand tramming of tubs?

Precautions in hand tramming

1. The trammer
   - before moving a tub, shall warn persons nearby who may be endangered.
   - shall not push the tub by holding at the buffer, or by putting hands inside the tub but shall push it from outside.
   - shall use hand gloves.
   - while pushing, shall walk outside the track, and keep an eye on the tub coming behind.
2. Distance between two tubs being pushed shall not be less than 10m, or they shall be coupled and moved together.
3. He shall not run tubs uncontrolled (unless permitted by the manager in writing).
4. While taking a tub down a gradient exceeding 1 in 20, trammer shall not go in front of the tub. If he cannot control the tubs from behind, he shall put a sprag before taking the tubs down.
5. Sufficient strong sprags of good quality and size shall be provided where required.
6. Every tub standing on a gradient exceeding 1 in 20, shall be blocked, chained or otherwise secured, unless it is suitably coupled to haulage rope or locomotive.

7. Tubs shall not be coupled or uncoupled when in motion or on a gradient.
8. Trammer shall wear leather boots and helmet and save himself from lumps of coal falling from tubs.
9. Precautions should be taken against other tubs approaching the place.

Q. 12. Write a short note on : (a) Jazz rails
(b) Drag

Jazz rails

Jazz rails are curved rails installed on direct haulage track to prevent runaways. The inner rails are super elevated, so that tubs moving at excessive speed due to runaway get unbalanced and are derailed. Tubs moving at normal speed can negotiate the curve.

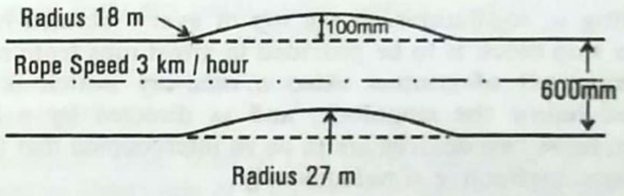


Fig : **Jazz rail**

Curvature depends on speed of tubs. It should be such that rope does not rub against the rails.

Jazz rails are provided

- below the runaway switch,
- 20m above working levels, and
- 50m above the main dip buffer.

On position indicator of the haulage, a mark is given to show the position when tubs are approaching jazz rails so that haulage khalasi may reduce speed.

Jazz rail is a simple and effective contrivance with no moving parts and requiring little attention.

Note : At some places rails with 2 curves in opposite direction are installed. These are known as 'goose neck' curves.

Drag or Back stay

It is a wrought iron fork which is attached to the tub axle of the last tub of a set when travelling up an inclined haulage roadway.

In case of breakage of haulage rope or a shackle, as the tubs start rolling down, free end of the drag catches in a sleeper of the track and derails the lowest tub.

Although the derailment causes some damage, it prevents the tubs running 'wild' down the incline.

When tubs are going down, the drag is hung from top of one of the tubs.

There are several types of drags, a common type, is 'C' type. (see sketch).

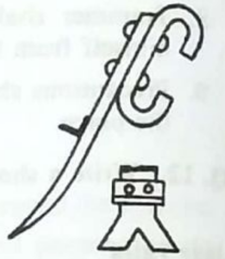


Fig. **Drag**

Q. 13. Give a simple sketch and describe intercoupled stop-block and run-away switch.

Inter coupled stop block and runaway-switch

According to regulations, at the top of every inclined haulage plane, a stop block is to be provided to arrest tubs from running or moving out of control. Also a runaway switch is to be provided below the stopblock, and as directed by a DGMS circular, these two devices are to be so intercoupled that they do not remain ineffective simultaneously.

Runaway switch is to be provided below the stop block at a distance greater than the length of a set of tubs, but the distance should not exceed the length of set of tubs by more than 10 metres.

As soon as tubs cross the stop block, looseman pulls the lever of the runaway switch so that the track is joined at the runaway switch and tubs can travel down. Once tubs cross the runaway switch, he releases the handle. If tubs some how jump the stopblock, the runaway switch derails the tubs, preventing them travelling 'wild' down the incline.

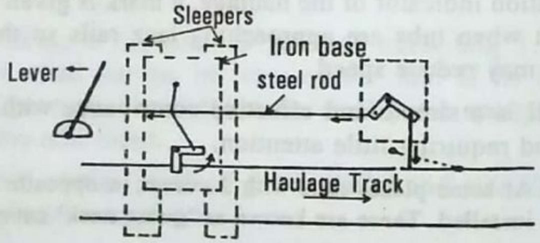


Fig. **Intercoupled stop-block & runaway-switch**

Q. 14. Describe general safety precautions for use of belt conveyors belowground.

Belt conveyor : Precautions

1. Belt conveyor shall be so installed that
   - (a) there is a clear travelling space of 1m free from obstruction between the conveyor and one side of the roadway,
   - (b) the conveyor or any of its parts does not scrape against wooden props or supports,
   - (c) anchoring of the return station of the conveyor is independent of the face or roadway support.
2. Where inclination of the conveyor is such that there is danger of sliding objects or material, suitable device shall be used to provide adequate protection against such danger.
3. Effective means of signalling shall be provided to give signal from any point of the roadway and the drivehead, if conveyor is longer than 30m.
4. Where men have to cross the conveyor, a bridge shall be provided.
5. Adequate space shall be kept above and below the conveyor, and on either side of it so that coal dust and spillage can be cleaned easily.
6. No person shall clean or grease a dangerous part of the conveyor when it is running.
7. Belt shall not be overloaded. Coal shall not be dumped into it when the belt is not running. If belt runs to one side, it shall be properly guarded.
8. No person shall ride on the conveyor.
9. (a) The manager shall formulate and enforce a Code of Practice for safe installation, operation, maintenance and use of belt conveyor belowground and submit it to Regional Inspector 30 days before commencing installation belowground. Regional Inspector may require modification as he thinks fit.
   - (b) Engineer shall be responsible for implementation of the Code of Practice.

Q. 15. Write briefly a Code of Practice for transport of heavy machinery by rope haulage in an underground mine.

Code of Practice for transport of heavy machinery

Duties of competent persons

1. All work of transport of heavy machinery/parts shall be under supervision of a competent person.
2. From the previous shift supervisor, he shall take information about work done, work to be done and the condition of track, trolleys, tools and tackles. At end of his shift, he will give similar information to the next shift supervisor.
3. He shall himself check condition of track, trolleys, safety appliances and signalling system. In case of defect, he shall get it rectified before starting transport.
4. Only approved types of clips, D-links and chains shall be used.
5. In beginning of the shift, he shall give necessary instructions to the *tyndal jamadar* and inform the haulage *khalasi*.
6. At curves, he shall personally supervise passage of trolleys.
7. Before loading/unloading trolley and before detaching the clip, he shall ensure that stopper and wedges are placed under the wheels and the trolley is fastened by chain to track.
8. In case of derailment, he will inform the superior official and arrange to re-rail it safely under his personal supervision.

Duties of *tyndal jamadar*

1. At beginning of shift he shall check the trolley, hook and D-link, and get wheels of the trolley greased.
2. He shall keep with the trolley, two jacks and adequate number of strong wooden wedges and stoppers.
3. He shall check signalling system.
4. Before loading and unloading the trolley, he shall place wooden wedges/stoppers under the wheels and secure the trolley by chain with the track. Before trolley is moved, he shall tie the load securely with steel rope/chain and turn-buckle.
5. Endless haulage rope shall be stopped, before attaching or detaching the trolley.
6. One person shall be near the signalling wires so that when required signal can be given immediately to stop the rope.
7. When the trolley is in motion, no person shall be in front of or adjacent to trolley, or behind the trolley in case of upward travel.

8. He shall pay special attention while trolley is negotiating a curve. Trolley shall be moved slowly and where required, a cut rope in good condition shall be used.
9. Loading/unloading shall not be done keeping the trolley at a slope.
10. All safety precautions shall be taken during re-railing work.

Note : In mines where transport of heavy equipment is required, the manager shall ensure proper installation of haulage track with heavy rails, concrete sleepers at 0.6m interval and below rail joints, proper track packing and check-rails at curves. Necessary dressing will be done to ensure adequate height/width. For keeping the road straight, where required the pillars will be split. Trolley of adequate capacity, rope of adequate strength, approved couplings, turn-buckles, jacks etc. will be arranged. Concerned persons will be duly trained.

B. Winding

Q. 1. Enumerate safety fittings and safety devices of a manwinding shaft and winding engine.

Safety fittings and devices for manwinding shaft

1. Signalling system : between top of the shaft and pit bottom; permanent landing or top inset of the shaft to winding engineman.
2. Code of signals : posted prominently at above places.
3. Guides : adequate no. to ensure smooth & safe travel of cage. In case of rope guides, cheese weights to be kept duly exposed.
4. Dogs : in the headgear above the topmost landing for holding the cage in the event of overwind.
5. Keps : at top of the shaft arranged to fall into 'on' position when the operating lever is released.

: keps or folding platfrom at every inset, with arrangement to lock in 'off' position leaving the shaft free and an automatic indicator which can be seen by the banksman.

6. Protective roofing : at pit bottom; gap vertical and horizontal between roofing and top of the cage shall not exceed 15cm when cage is resting at pit bottom.

7. Safety hook and catch plate : to release the rope in the event of overwinding and to hold the cage at the catch plate installed in the headgear.

8. Suspension gear : including rope cappel, safety hook, distribution plate, cage chains and safety chains.

9. Cage : covered at the top and two sides, with gates or fences at two other sides and a hand bar.

10. Notice : maximum no. of persons permitted to ride in a cage at a time.

11. Gates and fences : self operating at pit top and every landing.

12. Passbye : at pit bottom for persons to cross from one side to the other; height not less than 1.8m, width not less than 1.2m, free from obstruction.

13. Pit bottom buffer : at new shafts more than 200m deep. (DGMS Cir. Tech. 1/1993)

Safety fittings at winding engine

1. Drum flanges & rope fixture :
2. Brakes : atleast one to always remain 'on' until operated.
3. Automatic recording speed indicator :
4. Depth indicator
5. Automatic contrivance : at shafts deeper than 100m as per regulations (75m as decided by DGMS and coal companies)
6. Locking arrangement for drum clutch : interlocked with brake and with automatic indication of locking.
7. Two separate means of power supply :

Q. 2. What are guide ropes and keps? What is their purpose?

Guide ropes : Guide ropes are provided for smooth travel of cages in the shaft and to prevent them from swinging and colliding with each other. Rope guides are made of thick steel wires. 8 guide ropes are generally used, 4 at 4 corners of each cage. Cages slide along the guide ropes through shoes rigidly fitted to the cage corners. Guide ropes are suspended from the head gear and kept in tension by cheese-weights hung at their lower ends in the shaft bottom.

Keps : Keps are steel supports on which cage rests at pit top or at mid-landing so that rail track is always at the proper level for loading and unloading of tubs. When cage is on keps, the rope is released from weight of the cage. Keps prevent inadvertent lowering of the cage and save men entering/leaving the cage from falling into the shaft. Keps allow upward journey of the cage, after which they come back to original position automatically. For lowering the cage, cage is raised a bit, keps are withdrawn by banksman by operating the lever. After cage is lowered, banksman releases the lever, and keps come back to original position. There are 4 keps for each cage, 2 for each side.

Q. 3. What is overwinding? What damage does it cause? What actions are taken after overwinding?

Overwinding

Overwinding means upcoming cage travelling above the pit top due to failure of winding engine driver or control equipment to stop the engine in time.

Damage

Upcoming cage may dash against the headgear pulley with disastrous results.

Downgoing cage may land at the pit bottom at a high speed causing injuries to men in the cage.

Actions following an overwind

1. Persons in the down going cage will be given necessary first-aid.
2. Persons of the upgoing cage hanging from the catch plate shall be reassured.
3. Rope, rope cappel, engine and brake will be examined by the engineer. Shaft shall be covered by sleepers. Safety hook shall be lifted a bit by crane or winch. It will close. Shear pin will be fitted and then the cage lowered slowly on the sleepers. Men will come out.
4. Safety hook will be opened, cleaned, examined and refitted with new shear pin. Automatic contrivance, brake etc. shall be checked to find out cause of the overwind. Lower cage, its shoes and suspension gear will also be examined for defects/damage.
5. Rope will be recapped and sleepers removed.
6. Depth indicator shall be re-adjusted and a new marking given.
7. Automatic contrivance shall be re-set and tested.
8. After 5 trips up and down the shaft with fully loaded cage, the engineer will examine the cappel and other parts of the suspension gear.
9. The above jobs will be done under constant supervision of engineer or a competent person.
10. Regional Inspector shall be informed and a notice of dangerous occurrence given.

Q. 4. Write a short note on Automatic Contrivance.

Automatic Contrivance

Winding engine for **manwinding** shaft more than 100m depth is required to be provided with automatic contrivance to prevent :

- over speeding
- over winding
- excessive landing speed of down going cage
- cage running in wrong direction after over winding.

Automatic contrivance—

1. prevents over speeding of cage: it sounds an alarm when normal speed is exceeded, and if the speed is not reduced, it initiates brake application.
2. warns the driver when to commence retardation, and if the cage is not retarded, it applies brake.
3. cuts off the power and applies brake if after an over wind the cage starts in the wrong direction.
4. prevents the down going cage from landing at a speed greater than 1.5m/s (it is called 'slow banking').

In view of many accidents in shafts, DGMS and the coal companies have decided to provide Automatic Contrivance in shafts of depth between 75 and 100m also. (DGMS Cir. Tech. 1/1993).

Automatic Contrivance is tested by a competent person :

- for over-winding once in every 7 days by raising the cages in turn above the landing,
- for slow banking once in 3 months by attempting to land the descending cage at excessive speed.

Q. 5. Sketch and describe a safety hook.

Safety hook

1. A safety hook (or detaching hook) is fitted between the rope cappel and distribution plate, for safety of the upcoming cage in case of over winding.
2. A popular type of safety hook (King type) consists of 4 plates—2 outer plates and 2 inner plates. Outer plates are fixed and the inner plates are arranged face-to-face between the two outer plates and can move and open like scissors.

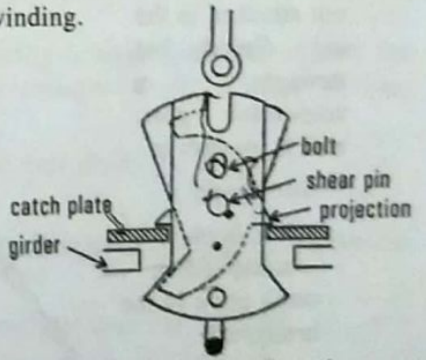


Fig . **Safety hook and catch plate**

3. Normally the inner plates are held in close position by a copper shear pin.

4. A matching catch plate (or bell plate) with a hole is fitted on a girder of head gear well below the head gear pulley.
5. In case of over winding, upper portion of the hook passes through the bell plate but projections of inner plates at the lower portion are pressed by bell plate. This breaks the shear pin. The inner plates open and sit on catch plate shear pin. The inner plates open and sit on catch plate suspending the cage there and simultaneously releasing the rope to go over the head gear pulley.
6. Cage is then brought down for examination and repair of safety hook.
7. As per regulations,
   - Safety hook is fitted in every manwinding shaft and in sinking shafts deeper than 45m.
   - It is taken out, cleaned, examined and re-fitted with a new shear pin once in 6 months (or when there is an over wind or when safety hook is hit by a falling stone or other object). In sinking shaft, inspection is done once a week and shear in is replaced by a new one.
   - Catch plate hole is measured once in 30 days.

Q. 6. Write a short note on Suspension Gear.

Suspension gear

1. Winding rope is not attached to the cage directly but through a suspension gear, which consists of
   - rope cappel
   - safety hook (with -corresponding catch plate in the headgear)
   - length adjusting chain (or Bull chain)
   - distribution plate, (also called triangular plate)

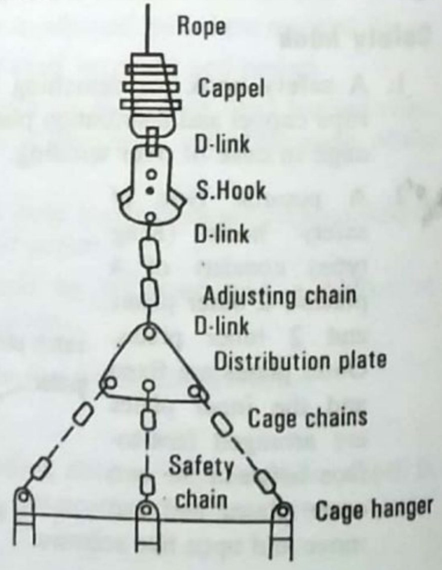


Fig. **Suspension Gear**

   - cage chains & safety chains ,
     each item joined to the next item by a D-link.
2. Suspension gear is replaced after 10 years or earlier. The parts are taken out, cleaned and examined by a competent person once in 6 months.

   In a sinking shaft, such examination is done once a week and the copper shear pin is replaced by a new one.

Q. 7. What precautions will be taken in travelling by a cage?

Precautions in travelling by cage

1. No person shall :
   - get into or out of the cage without indication by the banksman/onsetter.
   - attempt to go into or out of the cage once signal for running of the cage has been given.
   - ride a cage while materials or tubs are loaded into the other cage.
   - carry bulky materials (other than tools/instruments), except when engaged in shaft repair.
   - ride on top of the cage, unless when engaged in shaft repair and under competent supervision.
2. Banksman/onsetter shall close both cage gates, before signalling for motion.
3. Number of persons riding a cage shall not exceed the maximum fixed by the manager (@ atleast 0.2m^2 of floor area per person).
4. Person travelling in the cage shall:
   - hold the hand bar
   - not allow any part of his body or tools to project out of the cage
   - keep knees slightly bent and cap lamp on.

C. Pumping

Q. 1. Describe briefly types of pumps commonly used in mines.

Pumps commonly used in mines

Pumps commonly used in mines are—

Contrifugal pumps
Turbine pumps
Mono or Roto pumps
Submersible pumps
Reciprocating pumps
Drill pumps

Centrifugal pump

Centrifugal pump consists of an impeller rotating within a spiral casing. Impeller has fixed blades. When impeller rotates, water is drawn into the centre, carried round by the blades and thrown off at high pressure and velocity to periphery of the impeller due to centrifugal action. In the spiral casing, velocity is gradually reduced, its kinetic energy being converted into pressure energy. Such pumps have large capacity and small head.

Turbine pump

Turbine pump consists of an impeller rotating within a spiral casing which has stationary diffusing channels. As impeller rotates, water enters at the centre and is thrown at high speed into the spiral casing due to centrifugal action. Here the kinetic energy is converted into pressure energy with greater efficiency than in centrifugal pump due to diffusing channels. If it is a multi stage pump, this water enters into the eye of the next impeller. Each stage can develop 90m of head. Turbine pumps are widely used in mines for all purposes.

Mono or Roto pump

The mono (or roto) pump has a steel rotor rotating within a rubber stator. The stator is in the form of an internal double helix. The rotor is single helical in form and rolls in the stator with an eccentric motion given by special type of coupling. There is a constant seal and a space travelling towards one end. This space carries water. This pump is self priming and can deal with gritty and muddy water also. It is an ideal pump for cleaning of sump.

Submersible pump

It is a centrifugal pump, electrically driven, which can be run wholly submerged in water. The pump is hung by a rope and

operated from surface. Submersible pumps are used for dewatering old shafts and workings. Sudden inrush of water presents no problem, because the pump can operate fully submerged in water. In o/c mines, they are used for lowering ground water table. Pumps as large as 2500kW/6.6kV are available.

Reciprocating pump

It is a pump consisting of a piston or plunger which pumps water by a series of to-and-fro movements. It is an old type of pump. Such pumps were very widely used earlier but now they have been replaced by more efficient turbine pumps.

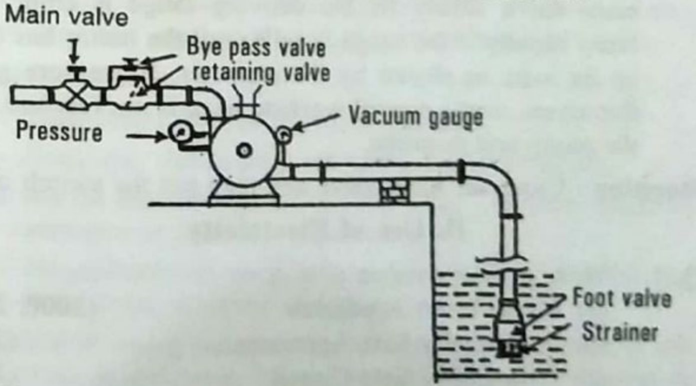
Drill pump

It is a small pump which can be attached to a coal drill as drill rod is attached. It is used, though not frequently, for removing a very small quantity of water which has accumulated at the face.

Q. 2. What are the various fittings and attachments of a turbine pump? How is such a pump started and stopped?

Fittings and attachments of turbine pump

1. **Strainer** : to prevent floating rubbish getting into the pump.
2. **Foot valve** : a non-return type of valve which prevents water flowing back from the pump and suction pipe into the sump.
3. **Vacuum gauge** : to indicate the suction lift.



4. **Pressure gauge** : to indicate delivery head developed by the pump.
5. **Sluice valve** : to regulate discharge of the pump.

6. **Retaining valve or non-return valve** : to close automatically and hold the delivery column when the pump stops due to failure of power supply.

7. **By pass valve** : for priming the pump.

8. **Priming funnel** : for priming from outside.

9. **Air cock** : on each stage of pump to permit release of air from the pump when it is being primed.

Q.3. Describe the method of starting and stopping a turbine pump.

Operation of turbine pump

The suction head should not normally exceed 4.5m and should in no case exceed 6m. (These figures include friction head in the suction pipe, foot valve, strainer, and bends).

Starting : The operations are as follows–

- See that the main valve is closed.
- Prime the pump and suction pipe with water, either from the delivery pipe through the by-pass valve or from outside source.
- Start the motor.
- When pump is running at full speed and has developed required head as shown by the pressure gauge, open the main valve slowly (if the delivery range is empty) (or fairly rapidly if the range is full) until the motor has taken up its load, as shown by the ammeter, If pressure gauge fluctuates, or the normal working head is not reached, stop the pump and re-prime.

Stopping : Close the main valve and then put the switch off.

D. Use of Electricity

Q. 1. Write a short note on :
(a) Flame Proof Apparatus (2006, 2008)
(b) Intrinsically Safe Apparatus (2005)
(c) Intrinsically Safe Circuit (2008)

Flame proof apparatus

1. Flame proof apparatus means an electrical apparatus whose electrical parts liable to produce sparks are enclosed in a flame proof enclosure.

A flame proof enclosure is one which is,

(a) made strong enough to withstand, without damage, any internal internal explosion of firedamp which may enter the enclosure (when the covers/access doors are properly secured), and

(b) of such design that the flame and hot gases of explosion in passing through the joints get cooled to such an extent that they cannot ignite the most inflammable firedamp-air mixture which may be present outside it.

2. Such an enclosure is made of approved design (with wide flanges and very small gap).

3. FLP enclosure will become unsafe if,
    - a part is replaced by one of wrong design,
    - parts are assembled wrongly, or design is changed in any way,
    - it is not maintained properly,
    - it is used incorrectly.

4. In specified areas of coal mine u.g. (where there is danger of accumulation of inflammable gas/coal dust), use of only FLP apparatus of type approved by DGMS is permitted.

5. This type of protection can be provided in apparatus of any voltage and any power used in mine underground.

Note : Points to note :

- Inflammable gas may enter FLP apparatus.
- Spark may also be produced during on/off operations.
- But the enclosure is so strong that it does not get damaged by explosion of inflammable gas inside it.
- Flanges/openings are so wide and their gap so small that the flame trying to escape gets adequately cooled.
- Use of wrong part, improper maintenance, or wrong use can make it dangerous. There have been several explosions in coal mines on this account.

Intrinsically safe apparatus

Intrinsically safe apparatus is that electrical apparatus which is so constructed that when connected and used under the prescribed conditions, any *sparking or thermal* effect that may occur in its normal working or under fault conditions, is incapable of causing an ignition of firedamp.

Explanation : Any spark produced from the circuit or the apparatus is so weak that it cannot ignite the inflammable gas.

Energy of the spark is limited by,

1. Limiting the voltage of source (to not more than 24V D.C or 15V A.C).
2. Diverting a part of the induced current to alternative path (by use of a shunt resistor, capacitor, rectifier, copper shunt, Zener diode, or Zener barrier).

Due to the above limitations, only low power apparatus like telephone, electric bell or environmental monitoring apparatus can be made intrinsically safe.

In special areas of coal mine underground, use of only intrinsically safe apparatus of design approved by DGMS is permitted.

Intrinsically safe circuit

Intrinsically safe circuit is an electrical circuit of special design which during normal working/designed fault conditions, is incapable of producing a spark which can ignite inflammable gas or vapour present in the surrounding atmosphere.

Such a circuit is possible only in small apparatus of voltage upto 24V D.C/15V A.C with operating current less than 1ampere.

Example : Circuits of gas detectors, electric bell, telephone, signalling/remote control/interlock circuits and circuits of environmental monitoring apparatus.

Q. 2. What are the places in a mine where only flameproof equipment is to be used?

Places where FLP equipment is to be used

In Deg. I mine – inbye of last ventilation connection.
In Deg. II mine – in all return airways,
– places within 90m of any face or goaf.
In Deg. III mine – in all return airways,
– places within 270m of any face or goaf.

Light fittings inbye of last ventilation connection in Deg. I mine, and at all places in Deg.II or Deg.III mine shall be flameproof.

Q. 3. What are the general rules for care of trailing cable in operation of mobile machinery.

Care of trailing cable of mobile machinery

1. Wherever possible, the machine shall be provided with a cable reeling device to cut down manual handling of cable.
2. Where the cable in not required to move, it shall be kept supported to prevent damage by roof/side falls, movement of machinery and damage by blasting projectiles.
3. Machine operators shall be trained in safe operation of the machine so that :
   - – cable is not dragged by the machine,
   - – it is not crushed by the machine or other equipment working nearby,
   - – it is protected from falling materials.
4. Cablemen/cable handlers shall also be given proper training.
5. Cablemen shall use protective gloves while handling live cables.
6. Trailing cable shall be examined periodically by the operator.
7. When not in use, supply to the cable shall be discontinned.

Q. 4. What do you understand by low, medium, high and extra high voltage? What is the maximum permissible voltage for use of equipment in the mine?

Voltage

Low voltage : upto 250V
Medium voltage : over 250 and upto 650V
High voltage : over 650 and upto 33,000V
Extra high voltage : over 33,000V

Permissible voltage limits

For transmission of power into a mine : 11,000V
For use in a mine : 6,600V

Special limits for use

(i) Hand held portable apparatus (e.g.drill) : 125V

(ii) Lighting : in u.g. mine : 125V
: in opencast mine or on surface : 250V
(iii) Portable hand lamp in u.g.mine : 30V
(iv) Remote control and pilot circuits : 30V
In fixed plants, if a bolted type plug in used : 650V

Q. 5. What is the maximum permissible length of trailing cable in a mine?

Permissible maximum length of trailing cable

1. In underground mine 100m
2. In underground mine for longwall machinery and equipment like shuttle car, LHD 250m
3. In opencast mine 300 m
4. In opencast mine for bucket wheel excavator of 11000 volts. 1000m

Note : These limits are as per recent amendments in Indian Electricity Rules, 1956.

Q. 6. Under what circumstances is power supply to a machine cut off ?

Power supply to a machine is cut off under the following circumstances :

1. In case of damage of its trailing cable, or sparking from cable, machine or switch.
2. When 1.25% or more methane gas is detected by flame safety lamp or gas detector.
3. During repair/testing of machine, cable or switch.
4. In case a person gets electric shock.
5. In case of fire.

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Chapter 23

FACE MACHINERY OF UNDERGROUND MINES

Q. 1. Write statutory provisions for : (2007)
Working and examination of machinery.

Working and examination of machinery

1. No machinery shall be operated otherwise than by or under constant supervision of a competent person.
2. In a gassy seam of 2nd or 3rd degree, no person shall be appointed to supervise or operate any electrical machinery, apparatus or appliance (other than a telephone or signalling device or an electric lamp or light), unless he holds a gas testing certificate. Every such person shall be provided with and carry an approved flame safety lamp while on duty.
3. Every person incharge of any machinery or appliance shall, before commencing work, see that it is in proper working order, and if he observes any defect therein, he shall immediately report the fact to the manager, engineer or other competent person.
4. Every person incharge of an air-receiver shall see that no extra weight is added to the safety valve and that the permissible pressure of air is not exceeded.
5. A competent person or persons appointed for the purpose shall, once atleast in every 7 days, make a thorough inspection of all machinery and plant in use, and shall record the results thereof in a B.P. book kept for the purpose. In respect of electrical machinery and plant, the competent person shall be an engineer or electrician holding qualifications specified in CEA (Safety & Electric Supply Regulation, 2010).

Q. 2. Write a short note on :
(a) SDL, (b) LHD

Side Discharge Loader or SDL

It is a popular coal loading machine of u.g. mines which can unload coal to the right or left of machine. SDL takes blasted coal from the face with bucket at front of the machine, transports and dumps coal onto chain conveyor, belt conveyor, tub or mine car. These days, small belt conveyors (called pony conveyors) installed near the faces are used in preference to chain/belt conveyors, tubs and mine cars for higher production and productivity.

Being crawler mounted, SDL can work in gradients upto 1 in 4.

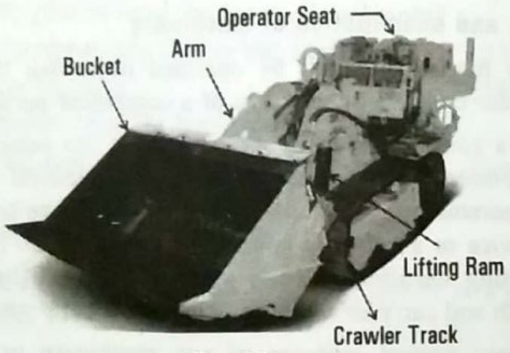

Fig. **SDL**

Initially SDLs were equipped with side tilting bucket which required greater headroom for unloading and resulted in much spillage of coal. SDLs are now provided with dual chain conveyor type side discharge bucket for easier unloading, lesser spillage and convenience of working in thinner seams. Height of machine over canopy is 2.1 m. Special models for working seams as thin as 1.3 m are also available.

The machine is powered by 550 V electric motor and all movements of bucket are done hydraulically for which hydraulic pack is mounted on machine itself.

SDLs are now manufactured by several companies in India in bucket capacities of 0.8 m^3, 1 m^3 and 1.5 m^3. SDLs of bucket capacity 1 m^3 for coal (0.6 m^3 for stone) are the most common. A 1.5 m^3 SDL is powered by 65 h.p., 550 V motor. Width of the machine is only 1.8 m (with bucket) making it suitable to take a right angle turn in a 3 m wide gallery easily.

Some SDLs have cable reel for trailing cable. Most SDLs are used without cable reel.

SDLs are used both for development and depillaring, and are increasingly replacing manual loading. One SDL on average loads about 100 tpd, but, is capable of much more with availability of adequate blasted coal and evacuation capacity, and efficient maintenance.

Safety features of SDL

1. Parking brake, service brake.
2. Dead man switch (foot operated).
3. Emergency stop.
4. Audio visual alarm.
5. Low oil level & high temperature power cut off switches.
6. Front & rear lights.
7. Canopy over operator seat .

Load Haul Dumper (LHD)

LHD is a tyre mounted loading machine which takes blasted coal from the face in its bucket, transports it over a distance and dumps it on the district chain or belt conveyor. Being tyre mounted, it runs faster than SDL (at speed upto 4 km/hr) and the chain/belt conveyor could be kept as far away as 90 m from the face. Power to he machine is fed by a trailing cable mounted on cable reel of the machine.

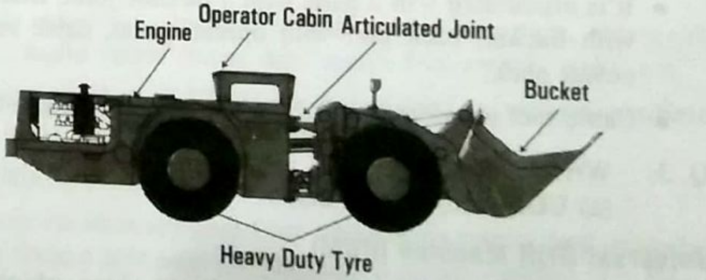

Fig. **LHD**

Being tyre mounted, LHD can work in gradient upto 1 in 7 where floor is dry and not weak. Such conditions are found in many of our mines.

Bucket, which is fitted in front of the machine, may be of 4 types: Tilting front discharge, Pusher plate front discharge, Tilting side discharge & Chain side discharge. Bi-directional chain buckets are the most common. Chain and pusher plate types are for relatively thin seams. All movements of bucket are by hydraulic pushers.

LHD is made in two parts which are joined by a flexible joint and can turn upto 100^0 , enabling it to take turn at a narrow gallery junction also.

No LHD is available for seam height less than 1.8 m. LHD can work in seams upto 2.4 m thick.

Popular models have bucket capacity 1.5 m^3 and 2.7/3 m^3 (for thick seams). A 1.5 m^3 LHD is powered by 50 h.p./550 V FLP motor. It has 100 m cable of 38 mm outer dia on a cable reel.

Recently in one mine of Singareni diesel powered LHD has been introduced.

For smooth working, galleries have to be maintained clear of scattered coal.

Safety features of LHD

These are similar to those of SDL. In addition, LHD has a power off switch which operates in case of excessive tension in trailing cable.

LHD differs from SDL in 3 respects

- LHD is wheel mounted.
- It is articulated – in 2 parts with a flexible joint, front part with bucket, back part with operator seat, cable reel & power pack.
- Cable reel is essential in LHD, because of its high speed.

Q. 3. Write a short note on :
(a) UDM, (b) Shuttle car.

Universal Drill Machine (UDM)

It is a crawler mounted electro-hydraulic machine which can drill blast-holes in the face, and also holes for roof/side/floor bolting at various angles. Hence it has been named universal drill machine or UDM.

UDM is provided with a 22 kW/550 V flameproof motor, a strong canopy and is so designed that it can move in narrow galleries and can take sharp turns.

Movement of drill boom and feed is by hydraulic pushers. The operator is required to control only a few levers to do fast drilling. He is saved from falling dust. The machine can drill 38 mm holes upto 1.8 m in one pass. By adding more drill rods, holes upto 20 m long can be drilled. Hence, it is found very useful in Blasting Gallery panels also.

Since hand held drill cannot drill long holes, progress per round in solid blasting is limited to 0.9 - 1 m. UDM permits drilling of longer holes easily and better progress per blast is possible. Due to speedy drilling, production and productivity of loading machines (SDL, LHD) also increase considerably.

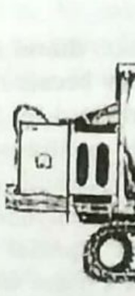

Fig. **Universal Drill Machine (UDM)**

Being crawler mounted, UDM can work in gradients upto 1 in 4 in seam heights upto 3.5 m. The machine is 1.6 m high, 4.6 m long and 1 m wide with a travelling speed upto 2.2 km/hr.

Safety provisions include brakes on track motors, emergency stop , audio visual alarm, dead man's foot switch, lights etc.

A large number of UDMs are being used in various coalfields and many more have been ordered.

Shuttle Car

Shuttle car receives coal from continuous miner and unloads it onto district belt conveyor through a feeder breaker. For this, it is fitted with a long trailing cable (200 m) mounted on the machine cable reel.

This tyre mounted machine can work in gradients upto 1 in 12 where the floor is hard and dry.

Eimco Elecon has manufactured shuttle cars of 8 tonne capacity for working with SDL, LHD or road header (AM 50). It can take a right angle turn at a junction of 4.5 m galleries. It takes only a minute to load or unload. When loaded, it can run at speed upto 5 km/hr. It is fitted with FLP electric motor.

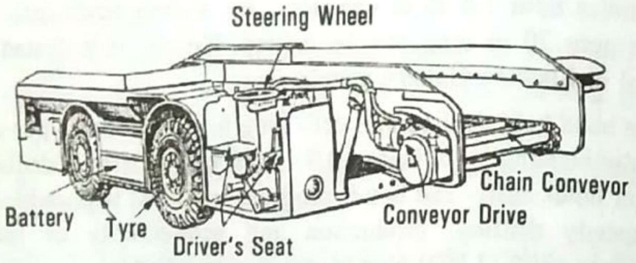

Fig. **Shuttle Car**

Use of 15 m^3 capacity (DBT Australia make) **diesel shuttle car** of articulated construction (named **ram car** because it is fitted with a ram and push plate) has been permitted by DGMS in one mine of Singareni for use with continuous miner. Conditions imposed are that emission of CO_2 shall not exceed 5000 ppm, CO 100 ppm, NO_2 10 ppm, aldehydes 10 ppm. Refuelling of this shuttle car is done at special refuelling stations only. Shuttle car is to be parked at a place which is not a travelling roadway and which does not obstruct flow of air.

Q. 4. What precautions will be taken if SDL or LHD is used in your district?

Safety precautions for SDL and LHD

Safety precautions for both these machines are identical, but, the limiting gradient of SDL is 1 in 4 and that of LHD 1 in 7. Safety precautions are listed below:

1. Machine shall be operated by a trained, authorised operator even during its inspection and testing. No other person shall be permitted to ride or interfere with its operation.
2. In beginning of the shift, operator shall check the machine, its brake, horn, front and rear lights and AVA. Fire extinguisher should be in place. In case of any defect, he shall not run the machine and shall inform the mining sirdar/overman.
3. Operator shall give a pre-start warning before starting the machine and shall give sufficient time to persons in the vicinity to move away.

4. Trailing cable shall be protected from damage during operation.
5. Helper shall use insulated gloves while handling the cable. He shall maintain a safe distance from machine in motion (atleast 5m).
6. The machine shall be operated carefully to avoid spillage. Any spillage coal would be cleared from time to time.
7. Before blasting, the machine shall be parked at a safe place.
8. When leaving the working place, the operator shall keep the machine in a safe position which does not endanger any person, lower the bucket to the floor, turn and lock levers in the neutral position and cut off supply from the gate-end box. The same procedure shall be followed at end of the shift.
9. No person shall cross the machine during its movement.
10. Vertical supports in the gallery shall be avoided as far as possible.
11. In case of leakage of oil or over heating of any part of machine, operator shall inform the competent person for checking/repair.

Q. 5. What is cutter loader? Write a brief description of Road Header and Longwall Shearer.

Cutter loader

A machine which can cut as well as load coal is called a cutter loader.

It does not need any drilling blasting, manpower required is less and production achieved is high.

But, the machine is capital intensive and can be productively used when transport, support, winding and ventilation arrangements are adequate, spare parts are easily available, workers well trained and the mine property has large reserves free from geological disturbances.

Cutter loader produces a lot of dust. Hence, it is fitted with a large number of water nozzles. Some cutter loaders are provided with dust extractors which suck the dust into a bag which is emptied periodically at a safe place.

Where cutter loader works, auxiliary ventilation is essential for diluting gas and airborne dust.

Road header, longwall shearer and continuous miner are examples of cutter loaders.

Road header

Road header is used for cutting coal and driving roadways in sedimentary rocks in which coal seams are found.

This crawler mounted machine has a boom with a large cutter head fitted with cutting picks. As cutter head rotates, the picks cut stone or coal, which is gathered by its gathering arms onto a chain conveyor situated in centre of the machine. Chain conveyor moves the material to the rear of machine for loading into a belt conveyor through bridge conveyor.

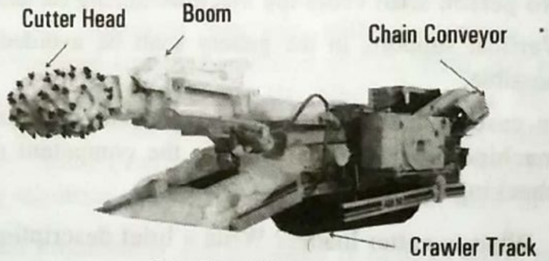

Fig. **Road Header**

Boom can be moved up or down or sideways as required to cover the entire face. Some designs of road header have two booms, some have bolters fitted on them.

Road header produces a lot of dust. For this reason, it is fitted with several water nozzles with a switch to cut off power if sprays are not working. An automatic methane sensor fitted o road header cuts off power to the machine automatically when CH_4 reaches 1.25% (or other value as set).

Road header is 7.5-10 m long heavy machine. A type of road header, Alpine Miner 50 (AM 50) is manufactured in India. It has several FLP motors with a total power of 155 kW. Some movements are hydraulically controlled for which power pack is mounted on the chassis.

In a heading driven by road header, exhaust overlap type auxiliary ventilation arrangement is provided. Road header is stopped in case of interruption in working of auxiliary fan. Operation of road header is supervised by an overman every shift and is under the overall charge of an assistant manager. Only a limited manpower is required in heading drivage.

Road headers have not been found cost effective in coal mines. They are now used selectively where drivage in stone may be required.

Longwall shearer

Longwall shearer is a cutter loader for cutting coal on longwall faces. It is mounted on armoured face conveyor (AFC) and runs on it with rack & pinion – rack on the AFC and pinion in the shearer. Depending on model, shearer has one or two ranging arms fitted with one or two cutting drums (1.8-2 m dia). Ranging arm can be raised or lowered to suit seam height but it cannot be moved sideways.

A machine with two cutting drums (one in front and one in the rear end) is known as double ended ranging drum shearer (DERD). In India only DERDs are used. This design permits taking cut as machine moves from one end of longwall face to the other and back. The front drum cuts about 70% height from the floor and the rear drum balance 30%.

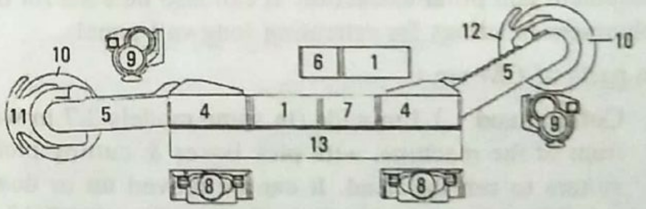

Fig. **Double Ended Ranging Drum Shearer (DERD)**

1. Motor, 2. Haulage Pump Motor, 3. Haulage Gear Box, 4. Gear Head Gear Box, 5. Raging Arm, 6. Radio Control Box, 7. Power Pack, 8. Under Frame Traction, 9. Role Back Traction Unit, 10. Cutting Drum, 11. Call, 12. Under Frame

Shearer takes 630-800 mm wide cut (web). The cut coal is transported by AFC to district belt conveyor. Speed of cutting automatically drops when hard coal is met.

Shearer is a multi-motor machine of 1.1 or 3.3 kV, some operations are hydraulically controlled. Cable handing is automatic.

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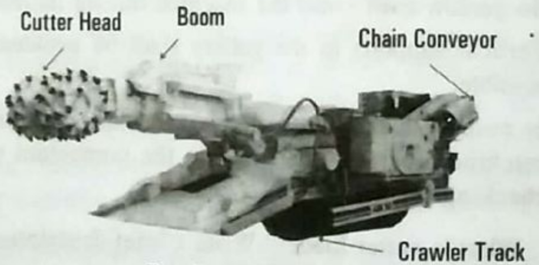

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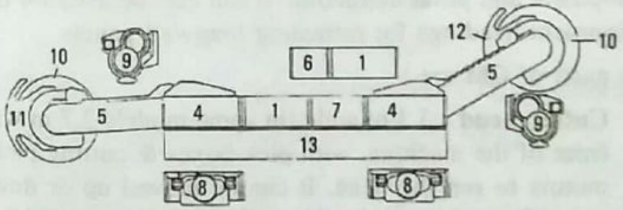

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Shearer is a multi-motor machine of 1.1 or 3.3 kV, some operations are hydraulically controlled. Cable handing is automatic.

Depending on model, it can work in seam heights upto 5 m , and cut 20-30 tonnes coal per minute.

Safety Features

- Single point start, many point stops.
- Emergency stop.
- Pre start audio warning of 5 seconds. If water pressure is not enough, cutting stops.
- Local as well as remote control.
- Water nozzles to suppress dust.
- CH_4 sensor which stops machine if CH_4 exceeds preset percentage.
- Lights.
- Anti-skid arrangement in case of steep seam (16°) model.

Q. 6. Write a short note on :
Continuous Miner and its safety features.
(2008, 2009, 2010)

Continuous miner

Continuous miner(CM) is a cutter-loader for Room & Pillar development and pillar extraction. It can also be used for driving development headings for retreating longwall panels.

Main parts of CM are :

1. **Cutter head :** 3.3 m wide (in some models 2.7 m wide) in front of the machine, with pick boxes & cutting picks and motors to run the head. It can be moved up or down but not sideways by hydraulic cylinders. It cuts 10-12 t coal per minute depending on machine model. Cutting speed reduces automatically with increase in hardness of coal.
2. **Gathering Arms :** Which collect the coal and feed it to the chain conveyor in centre of the machine.
3. **Central chain conveyor :** Which delivers the coal into a shuttle car standing behind the CM. Conveyor jib can be raised or lowered or slewed 45° on either side.
4. **Crawler mounted chassis :** Carrying also a power pack for hydraulic functions.

5. **Electric motors :** Input voltage of CM is 1100 V.
6. **Water sprays & Scrubber :** CM is fitted with several water sprays which suppress dust, reduce sparks and ventilate the area around the picks. Dust is sucked by a scrubber fan and wetted. Wet dust is picked up by a pump and discharged on to the cut coal.

Shuttle car, when fully loaded, transports coal to the district belt conveyor. Meanwhile another shuttle car takes load. For smooth operation 3 shuttle cars are need with one CM.

Coal on the face is cut by sumping the cutter head into the face. A 2.7 m wide cutter head makes two passes for cutting 5.4 m wide gallery. After the machine advances the face 10-15 m (called the 'cut out' distance), it travels to another face. Meanwhile roof bolting is done at the first face.

Depending upon the model, CM can work in seams 1.5 to 5 m thick. Length of CM 10-11 m, weight 50-60 tonnes. It can be operated on remote control also.

CM has a 'boom limit control switch' which helps the operator to set the floor & roof cutting heights.

Safety & protective devices of CM

1. Emergency stops at several places.
2. Low water & oil pressure switches.
3. Methane sensor (to stop cutting when CH_4 exceeds 0.5%).
4. Water sprays & interlock with water sprays.
5. Scrubber.
6. Pre-start signalling horn.
7. Lights.
8. Operator's canopy.
9. Earth leakage, short circuit & overload relays.

A low capacity CM (popularly termed LCCM) is used in two of our mines. It has cutting rate of 3.5 t/minute, working height 1.8-3.6 m.

Note :

1. A number of continuous miners are in operation in our Bord & Pillar workings. Gallery width being more, they are known

as Room & Pillar panels. Many more will be introduced shortly.

2. Layouts of continuous miner development and depillaring panels have already been given in the earlier pages of the book.

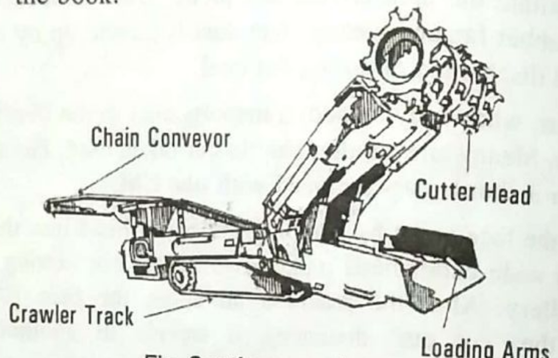

Fig. **Continuous miner**

* * *

Chapter 24

EQUIPMENT OF OPENCAST MINES

Q. 1. Write a short note on :
Safety features of a big dumper, Types of brakes and their periodical testing. (2009)

Safety features of large dumpers

1. Brake- service brake, parking brake, body holding brake.
2. Retarder brake to prevent over speeding during downhill journey.
3. Lights, parking light, dipper for light.
4. Horn.
5. Red view mirror, blind spot mirror.
6. Audio-visual alarm of approved type.
7. Rear vision system to assist the operator during reversal.
8. Seat belt and seat belt reminder.
9. Cabin guard extension—canopy over operator cabin.
10. Propeller shaft guard.
11. Tail gate protection—to protect operator during head-on or head-to-tail collision.
12. Speed limiting device.
13. Lifted body locking arrangement -- with hooter/indicator.
14. Fire suppression system (approved type).
15. Fire resistant hoses at hot zones.
16. Turbocharger guard and heat insulated paint on exhaust tube.
17. Battery cut off switch.
18. Mechanical steering lock—for safety of person working below the cabin with engine ON.
19. Retro-reflectors on all sides for visibility of dumper during night.

20. Proximity warning device to alert the operator when approaching another vehicle/obstruction.
21. Auto light dipper—to reduce glare on eyes of operators during night operation.
22. Load indicator and recorder—to enable the management to detect/prevent overloading.

Types of brakes

(a) Service brake
(b) Parking brake
(c) Retarder brake
(d) Dump brake (to keep dumper body steady during dumping of material)

Brake testing

All brakes are to be tested once every 15 days and record maintained with counter signature of engineer and manager.

Service brake : On operation of brake on a dumper running at 30kmph on a level road, it should stop dead within 21m.

Parking brake : Should be able to hold a loaded dumper on a gradient of 15^0 for atleast 10 minutes.

Other brakes : Functioning to be checked once in 15 days.

Brake testing area in workshop is kept fenced.

Q. 2. Write a short note on :
Fire in diesel operated HEMM (2006)

Fires in diesel operated HEMM

Diesel operated HEMM are vulnerable to catch fire destroying the machine and endangering life of the operator.

Preventive measures

1. Good quality hydraulic hoses and oil seals.
2. Tight joints and timely changing of leaky pipes/seals.
3. Not permitting accumulation of leaking diesel/hydraulic oil, grease, coal dust and jute on the machine. Periodical washing & cleaning.
4. Keeping caps of diesel & hydraulic tanks properly closed.

5. Providing guard on propeller shaft, so that it does not damage hydraulic oil hose.
6. Covering the engine exhaust pipe with glass wool or asbestos.
7. Not welding any pipe/tank containing oil. Cleaning oil, grease, dust, jute from the part before commencing welding.
8. Keeping battery connections tight and covered by an insulated tape. Using fuses and wires of correct size.
9. Releasing the parking brake before moving the machine.
10. Training concerned persons in safety precautions.
11. Cooling hot material by jets of water before loading.

Q. 3. Describe briefly : Rope Shovel.

Rope Shovel

Shovel is the most commonly used excavating equipment in opencast mines. This crawler chain mounted machine stands on bench floor and cuts soft soil/OB or blasted OB/coal from the face.

Construction. This large size machine is easy to understand. It is a mechanised form of hand shovel. Main parts are-

1. Bucket (or dipper)
2. Dipper stick
3. Boom
4. Machine house (A- frame and turntable)
5. Crawler chassis

Bucket is mounted rigidly at the end of dipper stick. Dipper stick moves forward and backward by its rack which sits on a pinion mounted on the boom.

At the top, bucket is connected to a hoist rope which passes over hoist pulley and is wound on the hoist rope drum. By turning the hoist drum, bucket can be raised or lowered.

Lower end of the boom is connected to front of the machine turntable by a pin joint and its upper end is held in position by boom ropes attached to the machine A-frame.

The machine house has a power unit, gears, drums, switches and operator cabin. It sits on a set of rollers on the chassis so that the machine house along with boom and bucket can be rotated through 360^0. Power unit maybe an electric motor getting power from an external source through a flexible trailing cable or it maybe a diesel engine. Diesel shovels are now rarely used in opencast coal mines in India.

Shovel runs on two sturdy crawler chains.

Since bucket movements are controlled by rope, shovel is known as rope shovel. In a hydraulic shovel, all movements of boom, boom stick and bucket are done hydraulically.

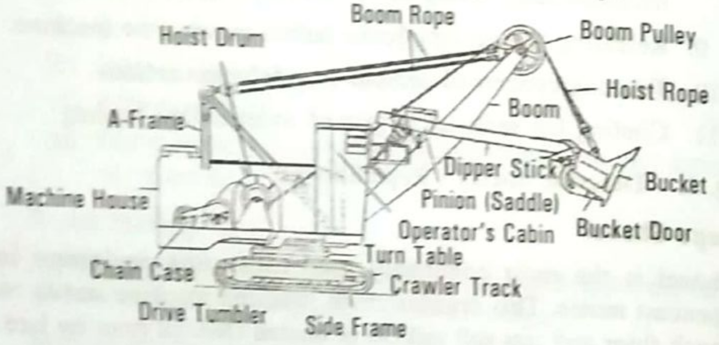

Fig. **Shovel**

Operation

For taking load, bucket is thrust into the material to be loaded with the help of hoist rope and dipper stick—this action is known as 'crowding'. Bucket is lifted up with the help of hoist rope, and as soon as it is full, dipper stick is pulled back—this action is known as 'retracting'. Now, the machine house with boom and loaded bucket is swung horizontally to position the bucket over the dumper. Bucket is bottom discharging and its door is opened by the trip rope. As soon as bucket is emptied, the door swings back to its original position and gets locked automatically. Bucket (with boom and machine house) is then swung back to take load again.

For good production, dumpers are so spotted that shovel swing time and angle is the minimum.

Shovel size is reckoned with the size of its bucket. In India 4.6, 8, 10 and 20m^3 electric shovels are commonly used.

Q. 4. What are the essential safety features of shovel?

Safety features of shovel

1. All functions cut off switch.

2. Swing, hoist, crowd, propel brakes.
3. Audio-visual alarm (AVA).
4. Seat belt.
5. Fire suppression system—approved type.
6. Horn, lights.
7. For hydraulic shovels — hydraulic cylinder travel limit switches.
   — hydraulic hoses of fire resistant types.

Q. 5. Describe briefly :
(a) Hydraulic shovel
(b) Backhoe

Hydraulic shovel

Like rope shovel, hydraulic shovel also runs on crawler tracks, and super structure is mounted on the turntable which is capable of swinging through 360^0. But, the functions which in a rope shovel are done by ropes are done by hydraulic cylinders in a hydraulic shovel. Electric motor or diesel engine of the shovel drives hydraulic pumps and the pressure developed is utilised for various operations.

Fig. **Hydraulic Shovel-Dumper**

The boom, which is smaller than that of rope shovel, is mounted on pin joints at front part of turntable. It can be moved up or down by two boom piston cylinders. Stick is mounted on top from an external source through a flexible trailing cable or it maybe a diesel engine. Diesel shovels are now rarely used in opencast coal mines in India.

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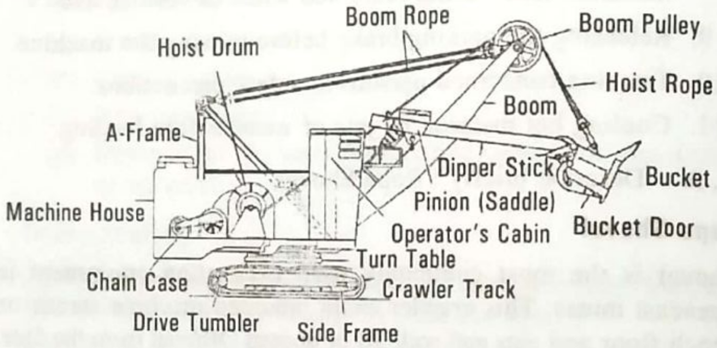

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The boom, which is smaller than that of rope shovel, is mounted on pin joints at front part of turntable. It can be moved up or down by two boom piston cylinders. Stick is mounted on top of the boom by a pin joint, and can be moved in a vertical plane by the stick piston cylinder. Bucket can be rotated in *wrist action* by the bucket cylinder.

For an equal bucket capacity, hydraulic shovel is much lighter than rope shovel—almost of half weight. Hence, it is much cheaper. It also gives better production because of a smaller cycle time and has fast travel speed. Inspite of all these advantages, hydraulic shovels have not become popular in India because their maintenance requires better skill, it is costlier and the machine is prone to breakdown.

Backhoe shovel

It is a diesel operated crawler mounted hydraulic shovel which stands on top of the bench and loads the material (soil or blasted coal/OB) into dumpers. In a way it is a large mechanised form of a spade. Open end of the bucket is towards the shovel.

The machine is very useful in mines where seepage is excessive or where rain water forms muck, or where coal pillars are extracted by opencast method. It is quite convenient for cutting garland drains and sump.

In Indian coal mines only small backhoes of capacity 1.5 to 3.5 m^3 are used for special purposes stated above.

Backhoe is kept on top of the bench and at right angles to the bench face to avoid danger to the machine from collapse of the face.

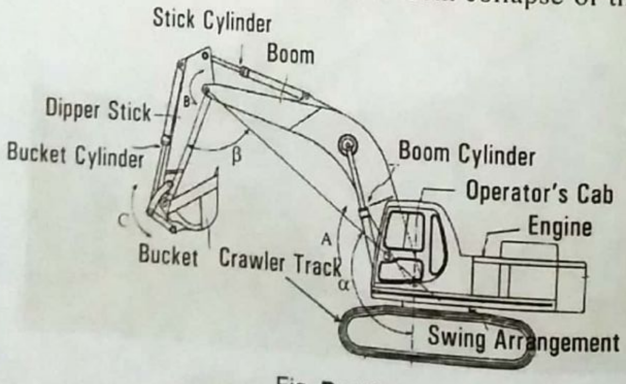

Fig. **Backhoe**

Q. 6. What do you know about dumper and its construction?

Dumper

Dumpers are used in almost all opencast mines. They are loaded by rope shovel, hydraulic shovel, backhoe or payloader to transport OB/coal.

Dumpers used in opencast mines are heavy duty trucks which,

- can withstand shocks of material loaded by shovel etc.
- can run well even on rough and temporary haul roads of the mine,
- can unload the material fast.

Size of dumper is chosen on basis of shovel size, such that it can be loaded in 4 to 5 bucket loads. Hence with smaller shovels, 35 or 50t capacity dumpers are used, while with bigger shovels 85t, 120t or 170t dumpers are used. 120t & 170t dumpers are used with 20-25m^3 capacity shovels.

85t capacity dumpers are diesel driven. 120t & 170t dumpers are diesel- electric. The diesel engine generates electricity which is used to drive electric motors mounted on wheels of the dumper.

Main parts of dumper are :

1. Chassis (to which are fitted suspension system, wheels & tyres).
2. Body and operator's cab.
3. Engine (and transmission, drive shaft & differential).

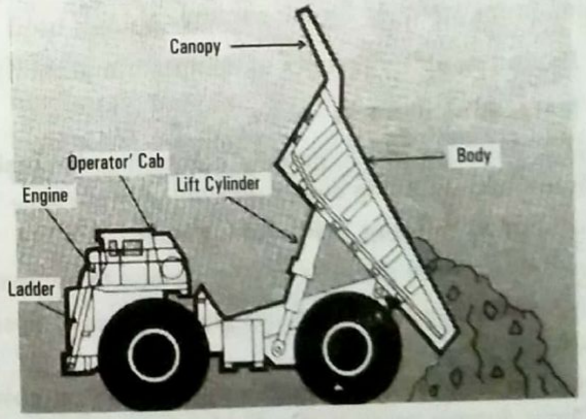

Fig. **Dumper**

4. Hydraulic system and air system (for controlling steering, body hoisting and brakes).

In ordinary trucks, engine and body are mounted on chassis

2over springs. In dumpers, engine and body sit on 4 suspension cylinders containing N_2 gas and some oil.

Dumper body is of a very sturdy construction, usually V-shaped, and it has a canopy for protection of the operator cabin. Body is open at the top, there is no tail gate and there is an arrangement to lift the body by powerful hydraulic rams. Body swings from its horizontal position around a fulcrum to nearly 70^0 to dump its load, and it is swung back to its original horizontal position on the chassis after unloading. Such dumpers are known as rear dumpers because they unload the material from the rear side.

Wheels of dumpers are huge in size. They are fitted with tubeless tyres—which have a flap of special design but no tube. Tubeless tyres are lighter, do not get as hot as tube tyres, air leaks slowly and they can be fitted faster than tube type tyres.

Ordinary trucks have clutch and gear box, but dumpers are provided with torque convertor and hydraulic transmission for swifter and smoother automatic gear shifting and reduced operator fatigue. Wheels of dumpers have a differential system which permits inner and outer wheels to run at different speeds while negotiating a curve. Steering is mechanical, but is assisted by hydraulic power for easy operation.

For repair work, the uplifted body of dumper is held supported by holding props provided for the purpose.

Q. 7. Enumerate safety features of dumpers (in general).

Safety features of dumpers

1. Brake : service brake, parking brake, retarder brake (to control over speeding during downhill journey).
2. Horn, light, indicator light, parking light.
3. Seat belt with belt reminder to alert operator to use seat belt.
4. Auto dipping system : to reduce glare on eyes of operators during night.
5. Speed limiting device : electronic or mechanical governor to limit dumper speed as decided by the manager.
6. Lifted body locking arrangement : with a hooter and indication of body in lifted position.
7. a. Rear view mirror,

   b. Blind spot mirror: to give operator a view of blind area of the dumper,

   c. Rear view vision system : to assist the operator during reversal.
8. Audio-visual alarm : of approved type.
9. a. Fire suppression system : factory fitment and approved type

   b. Fire resistant hoses in hot zones : to reduce chances of fire

   c. Electric wires and sleeves of fire resistant type

   d. Turbo-charger guard and exhaust tube coated with heat insulated paint,

   e. Battery cut off switch.
10. Propeller shaft guard : to prevent damage to hydraulic hoses.
11. Cabin guard extension : canopy covering operator's cabin fully.
12. Tail gate protection : to protect operator during head-on or head-to-tail collision.
13. Proximity warning device : to alert the operator when approaching other vehicle/obstruction.
14. Retro-reflective reflectors on all sides for dumper for visibility during night.
15. Load indicator & recorder : to enable management to detect/prevent over loading.
16. Emergency steering.
17. Mechanical steering lock : to prevent movement of steering and wheel when repair work is in progress under the cabin with the engine running.

(*Ref* : DGMS Cir. Tech. 5/2010)

Q. 8. How does dragline differ from a shovel? Describe constructional features of a dragline.

OR

Write a short note on : Dragline. (2010)

Dragline

It is a long boomed crane like machine which lifts earth, soft rock or blasted OB from the face into its bucket and dumps it straight into the de-coaled area of the quarry. For removal of OB by dragline, dumpers are not needed, and therefore, OB removal by dragline is much cheaper than OB removal by shovel. Also, there is freedom from problems of haulroad, traffic, steep gradients, water and muck.

Main parts of dragline are :

1. Bucket
2. Boom & A-frame
3. Machine house
4. Crawler chassis or walking pads.

Unlike shovel bucket, dragline bucket is not rigidly attached to machine structure. Rear end of the rectangular box like bucket, open at the front, is attached to dragline boom by means of hoist rope, while the front end is attached to the drag rope. All operations of lowering the bucket, pushing it into the material to be loaded and dragging it to take the load are done by manipulation of these ropes. With the loaded bucket, the boom and the machine house swing to dumping point where drag rope overturns the bucket to discharge the load.

Shovel stands on bench floor and excavates from the bench face, but the dragline sits on top of a working bench and excavates material from below the dragline base level. It can dig material above its level also but the efficiency of operation becomes very poor.

Dragline is used to extract the lowest overburden bench, just above the coal seam—other benches are excavated by shovel-dumper combination.

Dragline does not have a dipper stick like a shovel. Hence, its crowding force is low and for proper utilisation of dragline capacity, the OB must be well fragmented by blasting.

Very small draglines are mounted on crawler tracks like a shovel, but, all others are walking draglines. A walking dragline is mounted on a large circular, hollow 'tub' which has wide walking pads (or shoes) on two sides. In normal operating position, shoes are kept lifted off the ground. For walking, one pad is lifted up, advanced and lowered to touch the ground. The second pad is then lifted, advanced and lowered to touch the ground. In this way the dragline walks from one position to another somewhat as a man walks moving one foot and then the other. Walking speed of dragline is very low—only 0.2-0.4kmph.

Dragline cannot be marched from one mine to another. Its parts are assembled at the mine where it can be worked for its entire life (30-40 years). Assembling takes almost a year. Inspite of the machine being so large and heavy (over 2000 tonnes), pressure exerted on the ground is 1kg/cm^2 or less—lower than pressure of feet of men on the ground. This is made possible by the large hollow tub.

Machine house of dragline is very big. It houses different motors, rope drums, switches and operator cabin, and can rotate 360^0 around the chassis. Dragline boom is attached to chassis with a pin joint, whereas its upper end is balanced by a double boomed rope and several stay ropes.

Since the machine is very heavy, blasted OB should be properly dozed, almost level, before machine can be marched on it.

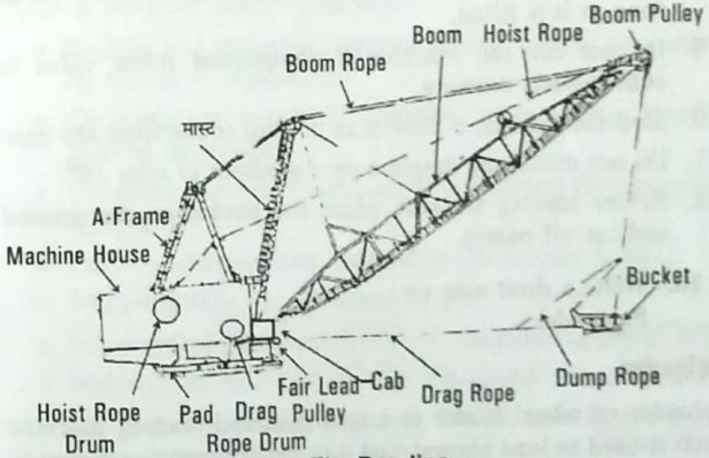

Fig. **Dragline**

10/70, 15/90, 20/90 & 24/96 draglines are common in India. A 24/96 dragline is one which has bucket of capacity 24m^3 and a boom 96m (320ft) long. This dragline costs around Rs. 70 crores—much more than cost of an aeroplane. Interruption of operation of dragline for just 10 minutes results in a loss of Rs. 10,000. Hence, two dragline operators are scheduled in each shift. It is worked 24 hours × 365 days except for maintenance time.

Q. 9. What are the safety precautions in dragline operation?

Safety precautions in dragline operation

1. Before commencing operation, check that nobody is inside

the dragline for maintenance work and no part is left open.

2. Inspect the machine all around to check condition of boom rope, hoist rope, drag rope, dump chain, trailing cable, railing and the ladder.
3. Check all brakes. Walking shoes should be in proper position.
4. No person, vehicle or equipment should be present in the swing range of the dragline.
5. Tub should be properly placed on the ground and it should be stable.
6. There should be no spilled oil, grease etc. in the machine.
7. Do not use the machine to lift too heavy and large boulders that would cause boom or bucket rope to snap.
8. Do not drag the bucket longer than necessary and lift it as soon as it is filled.
9. Do not run the machine if compressor relief valve is continuously blowing.
10. Stop the machine if there is an unusual sound from any part.
11. Do not march the dragline on a gradient of over 10^0.
12. Before leaving the seat, place the bucket on the ground and cut off power.

Q. 10. Write a short note on : Payloader.

Payloader

Payloader or wheel loader is a tyre mounted loading machine which is used to load blasted coal into small tippers or dumpers.

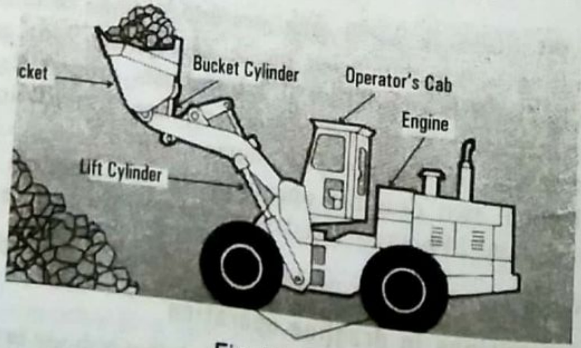

Fig. **Payloader**

It is a flexible and cheap machine utilised for loading trucks in coal stock yard, loading wagons in railway siding, and in some mines for loading coal at the face. It is not suitable for loading overburden. The machine is called a front end loader also because loading bucket is mounted at the front.

Safety precautions of payloader are similar to those of a dumper.

Q. 11. For what jobs is a dozer used in a mine? Describe its constructional and safety features.

Dozer

It is a diesel operated crawler chain mounted machine with a pusher blade at front for pushing loose material or for cutting soft earth. It is a very useful machine of opencast mines.

Dozer is used for various jobs like—

- Pushing and gathering scattered blasted material for loading by shovel or payloader.
- Cleaning the bench of coal/OB fallen during dumper loading by shovel.
- Levelling blasted OB and preparing ground for placement of dragline.
- Pushing and levelling material in OB or coal dump.
- Preparing face for placement of drill.
- Pushing coal into ground bunker of coal handling plant (CHP).
- Making haulroad, cutting side drains and removing muck.
- Shifting skid mounted blasting shelter, switch, pump and cable in the quarry.
- Levelling uneven ground and bush cleaning.
- Towing breakdown dumper to repair shed or workshop.
- Pushing scraper for loading.

Dozer can work on gradients as steep as 1 in 3.

Main parts of a dozer

- Pusher blades
- Arms
- Crawler chassis or undercarriage
- Engine, transmission
- Operator cab

Pusher blade is 5-6m wide, 1.2-1.3m high attached to the undercarriage by two pusher arms in the front of dozer. Pusher blade has a cutting blade at its lower edge. The pusher blade is moved up or down by two hydraulic rams. In angle type dozers (the commonly used dozers), blade can be tilted through a small angle for cutting earth.

Crawler units are attached on either side of undercarriage. The crawler chain consists of a number of track pads joined together and driven by a sprocket at the rear end and supported by an idler at the front. Upper portion of crawler chain runs on carrier rollers and it has track rollers at the lower portion inside the crawler chain.

There is an arrangement for tensioning the track chains. Both crawler chains have separate clutches. For steering dozer to the right, the right side is de-clutched (it stops), the left side is clutched, it moves and turns the dozer. For marching forward or backward, both the clutches are engaged.

Pressure of dozer on the ground is only about $1 kg/cm^2$.

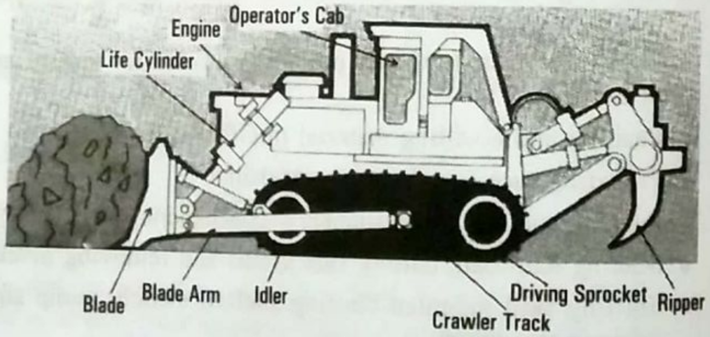

Fig. **Dozer (Ripper-Dozer)**

Capacity of dozer is designated by its engine power in kilowatt. 240-410kW dozers are quite common in India. But in bigger opencast mines, powerful dozers of capacity 810kW are used.

During marching from one place to another, dozer is not run fast to prevent undue wear of its parts.

In some mines tyre mounted dozers are used for light work like cleaning work near shovels.

Safety devices of dozer :

1. Brake, lights

2. Sturdy operator cabin (roll over type)
3. Hoses of fire resistant type
4. Portable fire extinguisher
5. Seat belt.

Q. 12. What safety precautions should be taken by dozer operator?

Precautions in dozer operations

1. Before moving the dozer, operator shall ensure that nobody is present in vicinity.
2. Before taking the dozer near the shovel, he shall obtain signal from shovel operator. Dozing shall be done after stopping the shovel and dumpers.
3. Dozer shall not be taken too near the quarry face or side to prevent accident by fall of material.
4. For dozing near edge of quarry bench or OB dump, dozer shall be at right angles to it as a precaution against danger of toppling of dozer. Many operators have lost their lives by toppling of dozer.
5. Dozer shall be parked on hard and level ground, at a safe place which does not obstruct movement of other machinery.
6. Dozer shall not be worked on a gradient more than 1 in 3.
7. Dozer shall not be used for dozing material at base of OB dump, since the material may slide and engulf the dozer and its operator. (Such accident occurred in Jayant opencast of NCL in Dec. 2008).
8. While marching the dozer from one place to another, it shall not be run in reverse position—it may crush a person behind.
9. Nobody shall stand on dozer blade or its arm while the engine is running.
10. Blade shall be lowered to the ground and engine stopped before any repair/adjustment is carried out.
11. Before leaving the machine, operator shall rest the blade on the ground and stop the engine.
12. Dozer produces a lot of noise. Operator shall use ear muffs for protection.

Q. 13. Write a short note on :
Ripper.

Ripper

Ripper is not a separate machine; it is a plough like attachment fitted to the rear end of the dozer to 'rip' the ground. It rips soil, soft stone or shale band like a plough ripping the earth.

In coal mines, a single shank ripper is used; in other places where ground is soft a two-shank ripper is used. It can be pushed 0.5-1m into the ground. Depth of ripping and dozer speed is varied by the operator according to hardness of strata. Movement of ripper is controlled by hydraulic pusher rams.

In New Kenda OCP (ECL) in the 80s, OB removal and coal extraction were done by using scrapers and ripper dozers, but, later when strata hardness increased with depth, blasting had to be done and shovel-dumpers were introduced.

Ripper is quite heavy and it reduces normal working efficiency of dozer. It is therefore used in mines where it is absolutely necessary.

Ripper provides a good means of OB removal and coal extraction in areas in close proximity of habitation. A number of ripper dozers are being used in MCL for loosening OB which is loaded by surface miners.

Q. 14. For what purpose scraper is used? How does it work? Describe briefly its construction.

Scraper

This diesel powered wheel mounted opencast equipment works somewhat like a 'lawn mower'. The machine has a cutting bucket at its centre, front end of which can be raised or lowered with help of hydraulic pushers by movement of levers in operator's cab. When lowered, it pushes into the ground. With scraper in this position, a dozer pushes the scraper from behind.

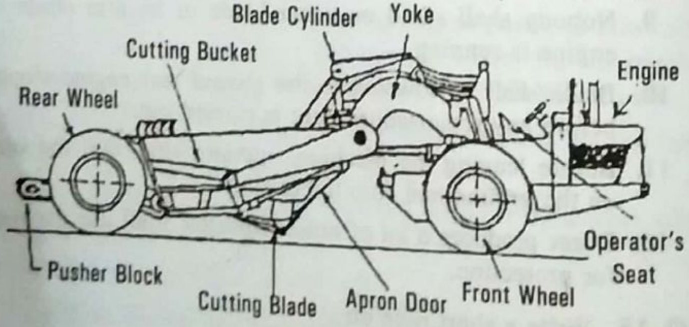

Fig. **Scraper**

A thin layer of 100-200mm is cut and by the time scrappr moves 30-40m, the bucket gets filled with the earth. Front end of the bucket is lifted and its open end comes in front of a closing door.

After taking the load, scraper moves with help of its engine and reaches the place where the material is to be dumped. Here, as the front portion of the bucket is lowered, bucket empties as scraper moves forming a layer 150-250mm thick. By the time scraper moves 50-60m, the bucket is fully empty. Its front portion is lifted and the scraper runs back to quarry face for taking another load. In this way, scraper cuts soil or soft strata layer by layer and spreads it into the OB dump.

Cycle time of scraper loading, transport of OB to dump, unloading and returning to OB face maybe 5-6 minutes depending on hardness of strata, lead and the skill of operator.

For a lead of 300-500m, 2-3 scrapers are needed with one dozer. Capacity of scraper (i.e. capacity of its bucket) varies with model from 8-22m^3. An empty scraper can run at a speed of upto 30kmph.

Where the ground is hard, it is loosened by a ripper dozer before it can be lifted by scraper.

Some 3 decades back, scrapers were used in some opencast mines of ECL (New Kenda, Ghanshyam, Dalurband, Neemcha etc.) and WCL (Bharatpur), but later shovel dumpers were used. Scrapers are now rarely used. But they would be required for mine reclamation (cutting soft soil, dumping it nearby and spreading it on top of OB dump, followed by levelling/grading).

Q. 15. Explain construction of blast hole drill.

Blast hole drill

Roller bit drill whose drill cuttings are flushed out by compressed air is known as blast hole drill. In our country 150, 260 and 310mm dia. electric blast hole drills are commonly used in opencast mines.

Blast hole drills are crawler mounted. By adding drill rods one after another deep holes can be drilled. For dragline benches, 40m or even longer holes are required.

Feed mechanism of the drill is by hydraulic pumps. Drill rod is fitted in a long mast. For adding drill rods or for bit changing, rod changer or carousel of the machine is used. Rod length is generally 10-12m. Depending on the model, the machine can drill holes of upto 3-5 rods.

Blast hole drills are equipped with 3 hydraulic jack for levelling the machine. Operation of each jack can be controlled by operator from operator cabin or by remote operation switch from outside the cabin. These jacks have 0.5m wide jack pads and they can be raised upto 0.6m from the ground.

Dust from blast hole is blown out by compressed air or extracted by dust extractor.

Some drills are equipped for angle drilling also. But due to practical difficulties, in India, only vertical blast holes are drilled.

Before propelling the drill from one place to another, the mast is lowered to prevent dis-balancing and overturning of the machine. After raising the mast, it is locked with locking arrangement provided.

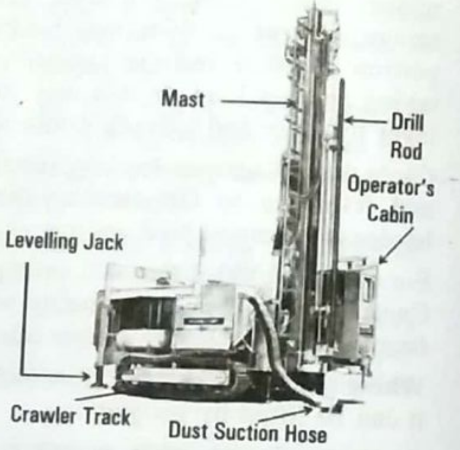

Fig. **Blast Hole Drill**

Q. 16. Enumerate essential safety features of a blast hole drill.

Safety features of blast hole drill

DGMS has specified safety features of blast hole drills (in 2008) as follows:

1. Emergency stop push buttons-
   - In operator cabin
   - On the main frame
   - At the rear of the drill
   - In the propel joystick
2. Propel joystick: for propelling from outside the cab. It is spring loaded so that propelling stops on releasing the joystick.
3. Propel and drilling interlock: so that only one of these two operations can be done at a time.
4. Mast (tower) lock and lock check valve.
5. Disc type brake.
6. High air temperature and low lube oil pressure switch.

7. Seat belt.
8. Fire suppression system of approved type. Hydraulic hoses of fire resistant type.
9. Turbo-charger guard.
10. Dust suppression system of approved type.
11. Guards and fencings around moving parts.

Note : Precautions to be taken while working with drilling machine have already been given in the chapter 'Opencast Mining'. A few more are listed below :

1. Check working of emergency trip.
2. Check working of all hydraulic systems individually.
3. Before lowering or raising the mast, ensure that there is nobody in its vicinity.
4. Level and tighten the jacks before commencing drilling.
5. Do not place the machine in cracked ground.
6. Do not unfold the trailing cable from the cable reel fully—leave atleast one loop in the reel.
7. Keep the machine at a safe place before blasting.

Q. 17. Write short notes on the following :
Grader
Surface miner (2010)
Bucket wheel excavator

Grader

Grader (or motor grader) is a machine for grading, cleaning and levelling the haulroad. It does not lift the material, but just pushes the loose material or scrapes the material to level the ground.

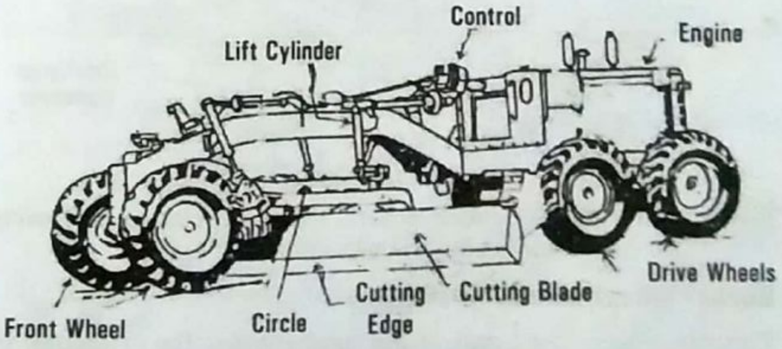

Fig. **Grader**

This wheel mounted diesel operated machine does all jobs with its long and strong blade, movement of which is controlled by hydraulic rams. Lower edge of pusher blade has a replaceable cutting edge.

Surface miner

In India use of Surface Miner in coal mines started in 1999 at Lakhanpur OCP of MCL. Now surface miners are used in many opencast mines.

This crawler mounted machine has a rotating cutting drum at the centre which is fitted with cutting picks for cutting a thin layer of 100-200mm from the ground. By cutting the layers one after another, the entire coal seam thickness can be excavated, but for this it needs a long and wide exposed area of coal. Cut coal falls into boom conveyor of the machine which loads the truck or small dumper at rear end of the machine or alternatively drops it on the floor to form heaps of coal. These heaps are then loaded and transported by payloader-truck combination to coal handling plant or siding.

Since the machine excavates thin layers, it can be utilised to mine stone bands of the seam separately for improving the quality of coal. In India, surface miners were introduced in opencast mines of coal with this purpose, but, they are now used also to extract coal from the vicinity of populated areas because it does not need any drilling blasting.

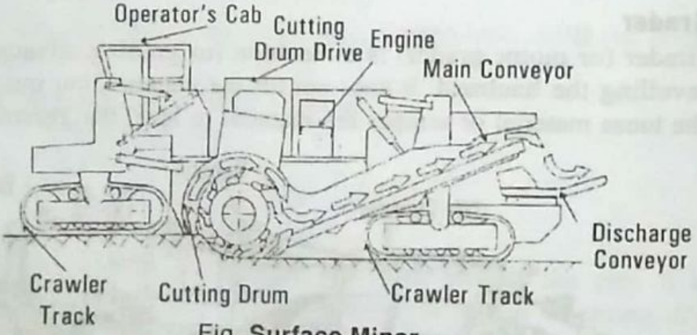

Fig. **Surface Miner**

Note : For utility of surface miners, its safety features and safety precautions in its use, see page no. 115.

Bucket wheel excavator (BWE)

This machine is used only in big lignite mines for extraction of soft OB and lignite.

The machine has a large rotating drum, the periphery of which has several cutting buckets that cut and get loaded with the material when the wheel moves. The filled buckets overturn with further movement of the wheel and drop the material onto the boom conveyor. Boom conveyor drops this material into the chute from which the discharge conveyor conveys it onto the system of mine belt conveyors.

Material excavated by BWE deployed in OB bench is carried by this conveyor system to the OB dump yard for spreading through spreader conveyor. Lignite excavated by BWE is carried by a separate belt conveyor system to surface lignite bunker which feeds the local power house.

Boom on which bucket is mounted can be moved up or down, and left or right as required. The boom and the discharge conveyor, each 30m long, are attached to the turntable which is mounted on a set of crawlers like a shovel.

One mine of Neyveli has four OB benches and one lignite bench. Each bench has a separate BWE. The machine comes in different sizes. Machine size is designated by size of the bucket. Some particulars of two BWEs of Neyveli Lignite Mines are given below :

	700litre BWE	1400litre BWE
Bucket size	700litre (0.7m^3)	1400litre (1.4m^3)
No. of buckets	9	10
Wheel dia.	8m	11m
Cutting height	20m	28m
Digging volume (m^3/hr)	2100	4200
Belt width	1800mm	2000mm

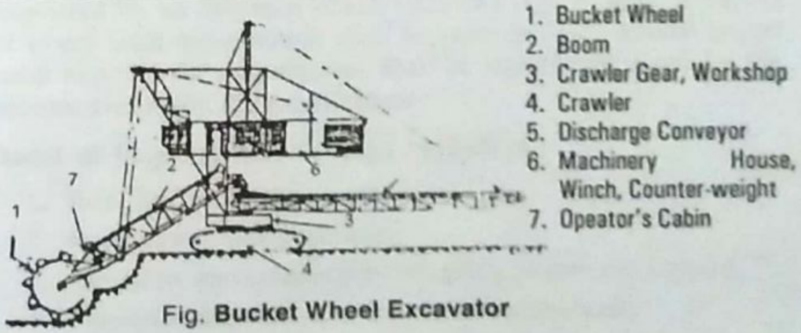

Fig. **Bucket Wheel Excavator**

Q. 18. Enumerate auxiliary equipment of opencast mines.

Auxiliary equipment of OC mines

Water tanker with sprinkler.

Mobile crane.

Tyre handler.

Truck mounted diesel filling pump.

Truck mounted lubrication van.

Mobile workshop.

Mobile lighting towers.

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Chapter 25

EXAMINATIONS & INSPECTIONS

Q. 1. What mine examination and inspection jobs can be given to an overman as per the Regulations?

See Q. 6 of chapter 'Duties and responsibilities'

Q. 2. What are the provisions of periodic inspections of mine outlets?

Inspection of mine outlets

1. Every shaft, incline and adit shall be examined, atleast once in every 7 days by an overman. He shall write a report of inspection in a bound-paged book kept for the purpose, and shall sign and date the same.
2. If in the inspection, any place is found to be unsafe, it shall not be used for any purpose other than as natural airway, until it is made safe. Report of every such action shall also be recorded in the report book.

Q. 3. Who inspects haulage and travelling roadways and at what interval?

What items are noted in inspection of haulage roadway?

Inspection of haulage and travelling roadways

All haulage and travelling roads and roadways including roadways leading to all the outlets of the mine which are in use, shall be inspected by an overman atleast once in every 7 days. A report of every such examination shall be recorded in a bound-paged book kept for the purpose, and shall be signed and dated by the person who made the examination.

Items of inspection of haulage roadways

1. Roof and sides are secure.
2. Roadway is white washed.
3. Junctions and coupling/un-coupling points are lighted.
4. Manholes are clear and free from obstruction.

5. No material has been dumped/stacked by the side of track.
6. Water is properly channelised.
7. Signalling wires are properly supported.
8. Track sleepers are properly nailed, track is properly graded and packing is ok.
9. There are no missing rollers, diversion pulleys.
10. Track rollers/pulleys are oiled, and not jammed.
11. Stop blocks, runaway switches, tub re-railers, buffers and other safety devices are ok.
12. Drag is being used behind upcoming set of tubs in direct haulage.
13. Printed copies of code of signals and notice of maximum number of tubs in a set are in place.
14. Loaders are not sitting near junctions awaiting empties.
15. Men are not travelling by haulage roadway.

Q. 4. To what points will you pay attention during inspection of travelling roadway underground?

Items of inspection of underground travelling roadway

1. Roadway is safe to travel—roof/sides are secure, supports are tight.
2. Roadway is neat, clean, free from accumulation of water.
3. In watery places, steps in the floor exist.
4. It is properly whitewashed.
5. Where gradient exceeds 30^0, steps exist.
6. Where travelling roadway crosses a haulage roadway, the crossover provided is in good condition with hand rails and adequate overhead space.
7. Galleries on either side are fenced.
8. Roadway is well ventilated.
9. Markings and direction indicators are in place.

Q. 5. What will you check in inspection of underground haulage room?

Inspection of underground haulage room

1. Engine room should be,

- Properly supported
- Properly ventilated
- Clean
- Whitewashed
- Free from dripping water
- Adequately lighted

2. Check,
   - Availability of fire extinguisher
   - Code of haulage signals
   - Signalling bell in efficient working condition
3. Brake is working effectively.
4. Any abnormal noise from the engine.
5. Booking pulleys in front of drum of direct haulage.
6. Rope being properly booked on the drum.
7. Position indicator functioning well.
8. Electricals cleaned.
9. Haulage *khalasi* has no complaint regarding haulage engine/haulage room.

Q. 6. What will you check during inspection of old workings?

Inspection of old workings

Inspection of old workings will include the following:

1. Condition of ventilation.
2. Accumulation of inflammable gas and black damp.
3. Indications of spontaneous heating.
4. Indications of seepage of water.
5. Stability of roof/sides.
6. Symptoms of spalling.
7. Water logging.

Q. 7. What precautions should be taken to prevent danger in inspection of old workings?

Precautions in inspection of old workings

1. Old workings should be kept isolated by isolation stoppings unless regular inspection is necessary.

2. Old workings which are required to be inspected, should be ventilated properly.
3. Route of old working inspection should be kept demarcated, cleaned and white washed. Cross galleries should be fenced off.
4. For inspection, the overman should take with him two assistants, safety lamp and CO detector.
5. 'V' notch should be provided to measure flow of water from adjacent workings. Regular monitoring should be done to ascertain any increase of water flow for taking preventive measures.
6. No member of inspection party should move in isolation.
7. If any member is separated during inspection, information should be sent to surface and other officials present underground so that search operations can be carried out under able guidance.

Q. 8. As overman incharge of a district of an underground coal mine, what will you do in the undernoted circumstances and why?

In underground working, the flame safety lamp gets suddenly extinguished. (2004)

Actions by overman on extinguishing of FSL

Extinguishing of flame safety lamp is an indication that oxygen in the air has reduced to less than 17% and a dangerous situation has arisen. This may be due to sudden disruption of ventilation or due to eruption of black damp or fire damp. Under the circumstances, the overman would take the following steps:

1. Withdraw all persons from the district.
2. Fence all approach roads to the district.
3. Take immediate action to rectify the defect in ventilation and to dilute the gas accumulation.
4. Not permit any person to enter the district other than persons needed for rectification work.
5. Inform the manager/assistant manager.
6. Allow work to commence in the district only after a thorough examination and declaration of the district safe and instructions of the manager.

7. Write a report at end of the shift.

Q. 9. If during inspection of old workings, flame safety lamp is extinguished, what steps will the overman take? (2008)

Extinguishing of FSL during inspection of old workings

1. Stop further inspection work.
2. Withdraw from the old workings any persons engaged in cleaning, dusting or other work. Come out of the district with assistants following the same route by which he had entered.
3. Fence all approach roads to old workings.
4. Inform the manager/assistant manager.
5. Arrange to improve ventilation as per advice of manager/assistant manager.
6. On normalisation of ventilation, inspect the workings and remove fencings.
7. Write a report at end of the shift.

Q. 10. What points will you check while inspecting a subsidence area?

Inspection of subsidence area

1. Formation or widening of cracks, need for filling *matti* or sand.
2. Sinking of ground.
3. Smell, smoke or other indications of fire u.g.
4. Accumulation of dry weeds and leaves.
5. Dumping of hot ash by men.
6. State of drainage of subsidence area. Drains around the subsidence area shall be clean so that outside water does not enter.
7. Fencing shall be in proper condition.
8. Any unauthorised construction.

Note : Many other questions and answers regarding examination and inspection (for example, inspection of fire stoppings, inspection of fire extinguishers) are included in relevant chapters. This chapter has been framed to draw attention to the type of questions that can be asked.

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Chapter 26

WHITEWASHING, LIGHTING AND NOISE

A. Whitewashing

Q. 1. What is the purpose of whitewashing the workings belowground? Which places are required to be whitewashed?

Whitewashing

The effect of light falling on any surface or its brightness depends on how much of light is scattered. Coal absorbs 95% and scatters only 5% of light. If whitewashed, the same surface scatters 50-60% of light. Whitewashing in the mine, therefore, increases the effect of light by 10 times.

Places to be whitewashed

(a) Every shaft inset, shaft bottom or siding and every bye-pass in regular use.

(b) Top and bottom of every haulage plane, every regular stopping place, siding, landing, pass-bye and junction, except within 100m of the face.

(c) Every travelling roadway.

(d) Every room and place housing an engine, motor and other apparatus, and

(e) Every first-aid station.

B. Lighting

Q. 2. Name the places where general lighting is to be provided in a mine.

Lighting

Adequate general lighting arrangements shall be provided during working hours at the following places:

(i) **On surface :** where natural lighting is insufficient, in engine house, in the vicinity of working shaft, O/C working, shunting or marshalling yard and all workplaces.

(ii) **Belowground:**

(a) Shaft inset and shaft bottom or siding which is in regular use,

(b) Travelling roadway (not necessary if all workers are provided with electric lamps).

(c) Top and bottom of self-acting incline in regular use.

(d) At every place in a haulage roadway, where tubs are regularly coupled or uncoupled or attached to or detached from haulage rope.

(e) Places where tubs are regularly loaded mechanically.

(f) Rooms and places housing an engine, motor or other apparatus.

(g) Depillaring face.

(h) First-aid stations belowground.

Q. 3. What lighting arrangements are made in a depillaring area?

Lighting arrangements in depillaring area

Floodlighting with 4 or more 250 W bulbs shall be provided in every depillaring area in deg.I seams where height of extraction is more than 3m. In deg. II and III seams, lighting in every depillaring face shall be provided by a cluster of 15-20 cap lamps placed on a stand (Cir. 36/1969 and 42/1961).

C. Noise

Q. 1. What damage is caused by excessive noise at the workplace?

Damage by noise

1. Loss of hearing.
2. Difficulty in communication, which increases chances of accident.
3. Irritation and tiredness which also increase chances of accident.

Q. 2. What is the permissible noise limit for working places in the mine?

Noise limits

▪ Warning limit	85 dB (A)
▪ Danger limit	90 dB (A)
▪ Compulsory ear protection	115 dB (A)
▪ No work limit	140 dB (A)

Q. 3. How is noise at the workplace reduced?

Measures to reduce noise

1. Oiling, greasing noisy machine parts.
2. Tightening loose nuts and bolts, using rubber or plastic packing.
3. Replacing worn-out/ damaged machine parts.
4. Fitting silencer on exhaust pipe.

Q. 4. When noise cannot be reduced, what shall be done?

1. Isolate the noise zone.
2. Keep the man away from noisy machinery.
3. Line the interior of machine cabin with noise absorbing material.
4. If inspite of all measures noise level exceeds 115 dB (A), provide and ensure use of reusable ear plugs or ear muffs of approved type.

Note : **Noise Induced Hearing Loss (NIHL) has been declared as a 'notified mining disease' in Feb. 2011.**

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Chapter 27

FIRST-AID

A. Arrangements for first-aid

Q. 1. What arrangements are made in mines for first-aid as per the Mines Rules?

Arrangements for first-aid

According to Mines Rules 1955, the following arrangements are made for first-aid in mines :

- First-aid Room on surface
- First-aid stations at specified places on surface, in opencast mines and in underground workings.
- First-aid outfit (pocket kit) with every overman, mining sirdar, shotfirer, fitter and electrician.
- Ambulance Van
- First-aid training to maximum number of employees, and refresher training to first aid certificate holders.

Q. 2. Write short notes on–

First aid Room (1991,1992,2004)

First-aid Station (1991,1992,1999,2000,2003)

First-aid Room

1. Mines Rules require that a first-aid room shall be provided on surface of every mine which employed more than 150 persons on any day during the previous calendar year.
2. It shall be situated at a convenient place and shall be used for first-aid only.
3. It shall be under the charge of a doctor.

   A nurse and a dresser or a compounder and a dresser shall be readily available at the first-aid room throughout the period when persons are at work in the mine.

If an adequately equipped dispensary or hospital belonging to the owner is situated near the mine, Chief Inspector or Inspector can grant exemption from this requirement.

4. The first-aid room shall have a floor space of not less than $10m^2$, It shall contain equipment as specified in the Second Schedule (namely a large bench and table, sink and water for washing hands, soap, towel, ATS, dressing, burn dressing, sterilised cotton, roller bandages, antiseptic medicines, triangular bandages, sets of splints, stretcher, blankets etc.)
5. Every person injured in the mine shall report for examination or treatment at the first-aid room, even if he has been rendered first-aid at or near the work place.

First-aid station

1. First-aid station is a place fixed by the manager for rendering first-aid to persons injured.
2. Every first-aid station is provided with equipment as prescribed in the Third Schedule of Mines Rules namely :
   - a stretcher and two blankets,
   - sets of splints (1.4m, 0.9m, 0.3m), and sufficient triangular bandages,
   - first-aid boxes (or cupboards), one per 150 persons, containing–
     (i) sufficient supply of large and small dressings and burn dressings,
     (ii) sufficient supply of sterilised cotton and adhesive plaster,
     (iii) roller bandages,
     (iv) Dettol or other antiseptic solution,
     (v) a tourniquet, scissors and safety pins,
     (v) soap.
3. First-aid stations shall be provided at the following places:

On surface : – At pit top/incline mouth.
– In workshop, screening plant and siding.

– other places where more than 50 persons are employed at a time.

In opencast : One first-aid station per 50 persons

In u.g. workings :– at pit bottom
– at every engine room
– near entrance to every district.

4. First-aid station is kept in charge of an official on duty nearby.

   A list of such persons is kept in the mine and also displayed in the first-aid station.
5. When any person is injured, the person in charge of the nearby first-aid station renders first-aid.

Note : First-aid pocket kit

It is provided with bandages (one small/one big), burn dressings, sterilised cotton, Dettol or other antiseptic.

These things are carried in a small box or packet which gives protection from dust and water.

B. Procedure of first-aid

Q. 3. (a) How will you give first-aid to a man affected by noxious gas in an inactive place? (1993)

(b) What will you do when a pump khalasi falls unconscious? (1981)

Person unconscious due to irrespirable atmosphere

1. The person may have become unconscious due to (a) shortage of oxygen (excess blackdamp) and (b) effect of a noxious gas.
2. The person shall be brought immediately to fresh air, without endangering own safety.

   Procedure of first aid shall be as follows :
   - Loosen all tight clothing and remove any foreign body (tobacco, false teeth etc.) from the mouth.
   - If breathing has stopped, lay the victim face downwards with his head on one side, and apply artificial respiration.

Continue treatment until breathing is restored or until the doctor arrives.

- Promote blood circulation by rubbing the limbs and keeping the body warm by blankets. Legs should be raised and massaged towards the heart.
- When the patient is fully conscious, give him tea or coffee.
- Keep the patient at rest, prevent him from becoming excited. Transport to surface on a stretcher.

Q. 4. What first aid will you give to a person who has received a bleeding injury?

First-aid of bleeding injury

1. The injured person shall be brought to a clean place and placed in a comfortable position. Blood escapes with less force when the victim sits, and still less when he lies down.
2. If there is no fracture, the bleeding part shall be elevated.
3. The wound shall be exposed, removing as little clothing as possible. Any visible foreign bodies shall be picked out, and the wound wiped out lightly with a clean dressing. A clot shall not be dressed. Sterilized dressing shall be applied.
4. If it is bleeding, a sterile gauze pad shall be placed over the wound and kept pressed with fingers until the blood clots. If bleeding continues, tourniquet (or a bandage 50-60mm wide and 1.2m long), shall be applied only tight enough to control bleeding. Tourniquet shall be loosened every 15 minutes. Time of applying tourniquet shall be noted on a piece of paper and attached to it.
5. Victim shall be transported to the doctor on a stretcher.
6. To prevent shock, he shall be kept covered by blankets. No stimulant shall be given by mouth.

Q. 5. (a) What are the symptoms of internal bleeding ? (1978)

(b) A loader injured by roof fall is showing symptoms of internal bleeding, what first-aid will you give?

Symptoms of internal bleeding

Bleeding : From nose, ears, mouth.

Restlessness : Throwing about of arms and pulling the clothing at the neck.

Air hunger : Yawning, sighing, call for air, distressed efforts to breathe, severe thirst.

First aid

1. The injured loader shall be laid on a stretcher and covered with a blanket.
2. He shall be transported to the doctor as soon as possible.
3. Attendance clerk shall be asked to inform the doctor and keep ambulance ready.

Note : Internal bleeding may be from injury, such as a crush, blow, fracture of rib, of the pelvis or of the skull. Internal bleeding may be visible or it may be concealed. Signs at the place of accident and an idea of circumstances would indicate possible internal injury.

Q. 6. What first-aid will you give to a person who has been electrocuted?

First-aid of electric shock

1. Power shall be out off.
2. If it is not possible, victim shall be removed from the electrical apparatus with the help of wooden stick, belt, caplamp cable etc.
3. If clothes have caught fire, it shall be quenched.
4. If breathing has stopped, artificial respiration shall be given.
5. When he regains consciousness, the burn injuries shall be treated.
6. He shall be kept covered by blankets, and transported to the doctor as soon as possible.
7. He may be given tea, coffee.

Q. 7. What is meant by'shock'? Give its symptoms and first-aid.

Shock

Shock is a condition of severe depression of the vital functions, which affects specially the heart and blood circulation. Every injury causes some shock. It is a common cause of death following severe injuries.

Symptoms of shock

Pale face, sweat on forehead, body cold, pulse weak but fast, weakness (patient neither shrieks nor screams, does not complain of anything, his glance is fixed and remote.)

First aid of shock

- The injured person shall be reassured.
- He shall be brought to fresh air. He shall be laid with head low and turned to one side, unless there is an injury to head, abdomen, or chest, when the head and shoulders should be raised slightly and supported.
- Clothing about the neck, chest and waist shall be loosened.
- Movements shall be kept to the minimum, otherwise pain will increase.
- He shall be laid on stretcher and covered with blanket.
- If the victim is conscious, hot tea or coffee may be given in sips.
- Heat or friction shall never be applied to the limbs.
- He shall be transported to be doctor as early as possible.

Q. 8. What first-aid will you give in case of fracture of bone?

First aid of fracture of bone

1. No attempt shall be made to reset the broken bone. It shall be given support. If injured person is to be moved even for a short distance, injured part shall first be immobilised by bandage, using victim's body as the natural support.
2. If required, additional support shall be given by splints. Splints should be sufficiently long to immobilise the joint above and below the fracture. Paddings made from triangular bandage shall be placed under the splints and the splints shall be applied over the clothes. They shall be held in position by bandages applied firmly, but not too tightly as to prevent circulation of blood.
3. If wound is bleeding, it shall be attended to first before treating the fracture.

4. The injured person shall be carried on stretcher, covered by blankets. He shall be re-assured and reached to the doctor at the earliest possible.

Note : 1. While extricating a person buried by a roof fall or side fall, great care shall be taken as there is possibility of one or more fractures. In case of fracture of head, jaws, back bone, ribs and pelvis, extra care shall be taken. Seeing the position of the injured person, assessment shall be made of the part of body which could have been fractured.

2. Due to wrong method of first aid, many serious accidents in coal mines turn out to be fatal and many persons become paralytic.

This aspect is taken too lightly by many mine managements, not realising the misery of the family of the victim. Even the right type of stretcher may not be found when needed.

Q. 9. What first-aid will you give to a person who has received an injury in the backbone? (1993)

First-aid for injury in backbone

An injury in the backbone is a serious emergency as there may be a fracture of the spine, which has its complications of complete or partial paralysis and/or loss of sensation in the lower limbs. First-aid will consist of treatment for shock, immobilisation, loading into stretcher, transport to surface, and then to the hospital, avoiding all movements of the neck and trunk.

The procedure may be as follows :

1. Place pads between the victim's ankles, knees and thighs. Apply a figure of 8 bandage around his ankles and feet, the knot being tied under the soles of the feet. Apply broad bandage round his knees and thighs over the intervening pads.
2. Put him on a firm hard level ground.
3. Treat him for shock i.e. re-assure the victim, loosen all clothing about neck, chest and waist, cover him up with a blanket.
4. Prepare stretcher. Cover it up with a folded blanket and then blanket the stretcher .
5. Turn the stretcher on to its side, close to the front of the victim's body. Place 2 rolled blankets–one across the front of his shoulder and the other across front of his hips. Holding the stretcher in close contact with his body,

carefully turn the stretcher and the victim as one, into the correct position for carrying. The turning of the victim on its injured face may be assisted by the bearer pulling on the edge of the blanket under him. Comfortably support the head, cover up with blanket, secure the victim to the stretcher. Arrange for transport to the surface, and then to the hospital in an ambulance.

During handling, victim's body will not be twisted or over extended. It will be necessary for one person to apply firm but gentle support to the head and face, so as to prevent neck movements, and for another person to steady and support the lower limbs, so as to prevent trunk movements. The victim will be transported in face downwards position.

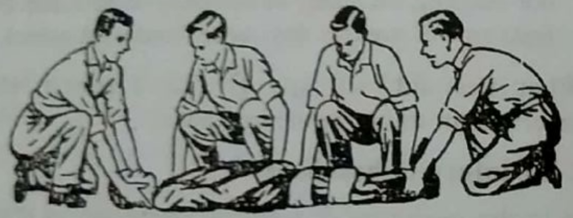

Fig : **Fracture of back bone : 3 bandages**

Q. 10. Describe briefly–

First-aid to a person who has a fractured thigh bone.

(1976, 1979)

First-aid of fractured thigh bone

First-aid of fractured thigh bone will be similar to that of the back bone, but instead of 3, seven bandages shall be applied as given below :

1. Put injured person on firm level ground.
2. Apply a well-padded splint between the limbs, extending from the crutch to the foot.
3. Tie feet and ankles together with a figure of 8 bandage to include the splint after placing padding between ankles and knees.

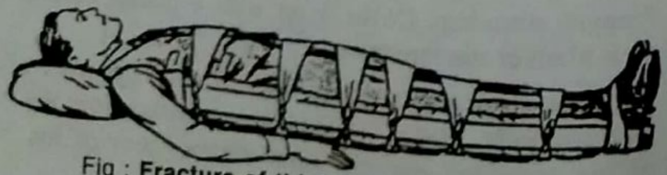

Fig : **Fracture of thigh bone : 7 bandages**

4. Apply 6 more bandges as given below :
   (1) The chest, just below the armpits.
   (2) The pelvis, in line with the hip joint.
   (3) Both thighs, where possible above the fracture.
   (4) Both thighs, below the fracture.
   (5) Both legs.
   (6) Both knees (broad bandages).
5. Treat the person for shock ie. re-assure him loosen the clothing about neck, chest and waist and cover him up with a blanket.
6. Cover the stretcher with folded blanket and then blanket the stretcher.
7. Load the victim on stretcher (as described in the question of fracture of backbone).
8. Arrange for speedy transport to the hospital preventing jerks.

Note : Life of the injured person depends on care taken in first-aid. It is criminal to kill a person by wrong first-aid.

C. Transport of the injured person

Q. 11. Describe briefly the general requirements for transport of the injured person from the work place to the hospital.

Requirements for transport of the injured person

1. Adequate no. of stretchers to be available in the districts. Design to suit local conditions. For transport in cage, stretcher should be of proper size with telescopic handles.
2. Strong but light stretchers to be kept well maintained.
3. Adequate no.of persons to be identified and trained in carrying the stretcher.
4. Sufficient extra persons to be given to relieve stretcher bearers. For a distance of 500-600m on a gradient 1 in 6 underground, about 10 such persons may be required.
5. Base of stretcher should be hardened in case of injury of backbone.

6. Shortest but safe route to be taken for speedy transport without undue hurry.
7. A person should accompany the stretcher who can–
   - keep an eye on breathing, pulse, bleeding
   - open the tourniquet every 15 minutes and see the condition of bleeding
   - inform the doctor of the type of accident, change in condition of the injured person from time to time and the first-aid given.
8. Even on inclined road, stretcher should be carried level with feet first.
9. Ambulance van should be fully equipped with life saving drugs, appliances needed for emergency (e.g.oxygen cylinders), and a nurse. (7th safety conference recommendation).

Note : Incorrect delayed transport may result in paralysis or even death of the injured person.

Q. 12. What procedure will you adopt to treat a person who has been recovered unconscious from an irrespirable atmosphere?

F.Aid of person unconscious due to gas or lack of O_2

The person may have become unconscious due to

- shortage of oxygen
- due to displacement of air by methane, or
- due to effect of CO or H_2S

The general procedure will be as follows :

1. Loosen all tight clothing and remove any foreign body (tobacco, false teeth etc) from the mouth.
2. Remove the victim to fresh air, as soon as possible, keeping him lying on the right side.
3. Apply artificial respiration by Schafer's method, if breathing has stopped or is weak and intermittant. The treatment should be continued persistently for a long time. Administer fresh oxygen by resuscitating apparatus, as soon as it becomes available.

4. Cover the victim by blanket and promote blood circulation by rubbing the limbs. The lower limbs, after raising them, should be massaged towards the heart.
5. When the victim is fully conscious, give tea or coffee as stimulant.
6. Keep him at rest. Arrange to transport him to surface on stretcher. If he is affected by nitrous fumes, give an emetic, such as common salt, dissolved in water. (emetic should not be given when affected by other gases).
7. If there is severe bleeding due to some injury, this must be attended first of all.

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Chapter 28

EMERGENCY PLAN AND RESCUE

Q. 1. What is Emergency Plan? (2001,2005)

Describe the statutory provisions for Emergency Plan.

Emergency Plan

Emergency Plan is a general programme of action to be followed in the event of a fire, explosion, inundation or other emergency in the mine for dealing with the situation effectively and efficiently.

It includes duties and responsibilities of mine officials, keymen and telephone operators so that every such person knows what is expected of him in the event of an emergency in the mine.

It is prepared by the manager and enforced at the mine after approval by the Regional Inspector. It is kept ready at every u.g. mine.

Provisions of regulations

1. Within 30 days of opening or reopening a mine which has u.g. workings, the manager shall prepare an Emergency Plan and send a copy to the Regional Inspector.
2. Emergency Plan shall include duties and responsibilities of all officials, keymen and telephone operators of the mine in the event of an emergency.
3. The Regional Inspector may approve the action plan as it is or with changes as he thinks fit, and such approved action plan shall be enforced at the mine.
4. All officials and keymen shall be thoroughly instructed in their duties as per the Emergency Plan to avoid contradictory orders and confusion at the time when prompt and efficient action is required.
5. On receiving information of an emergency, the manager, and in his absence the principal official present on the surface, shall immediately put the action plan in operation.

Q. 2. State the provisions of Mines Rescue Rules 1985 regarding :

(a) Duties of manager in emergency. (2010)

(b) Accommodation at the below ground mine for persons engaged in rescue work.

Duties of manager in emergency

1. On receiving information of any emergency likely to require the services of a rescue team, the manager or in his absence the Principal Official present at the surface shall immediately set in motion the Emergency Plan, which will include :

(a) Informing,

- Rescue station/rescue room serving the mine
- Higher officials
- Regional Inspector
- Owners, agents or managers of nearby mines to make available the services of rescue trained persons of their mines.

(b) Summoning,

- Rescue trained persons of the mine
- Key personnel
- Medical assistance

(c) Activating control rooms.

(d) Assessing location, extent and consequences of emergency.

(e) Assessing location of survivors, identifying safe escape routes and guiding escape of survivors.

(f) Acquiring information about condition of mine fan, winding engine, shafts, composition of fan-exhaust air.

(g) Deciding manner of limiting the consequences (by barricading, regulating/reversing ventilation, building temporary stoppings etc).

(h) Assessing help/inputs required.

(i) Setting up a system of issuing authorisations of men required to go u.g.

2. All rescue and recovery work shall be conducted under control, direction and supervision of manager of the mine or in his absence, the principal official present on surface.

However, in case of major emergency like ignition, explosion, big u.g. fire or an accident involving a number of persons, manager or principal official shall take guidance from a group consisting of :

- A senior official of management,
- A representative of DGMS,
- Concerned rescue station superintendent,
- Representative of recognised trade union.

Manager shall himself take decisions so long such a group is not formed.

Note : Principal official means the senior-most official of mining discipline on duty in the mine.

Accommodation for persons engaged in rescue work

- Whenever rescue trained persons are engaged in rescue or recovery work at a belowground mine, there shall be provided at such mine suitable accommodation for storage and charging of rescue apparatus.
- Accommodation shall be situated at a convenient place near the entrance in use.
- It shall be properly ventilated and lighted.
- Adequate quantity of cool and wholesome drinking water shall be provided at such accommodation and proper canteen facility shall be organised for rescue workers.

Q. 3. What is a Fresh Air Base? State briefly provisions of the Mines Rescue Rules 1985 regarding FAB? (1990; 1994)

Fresh Air Base

1. When rescue/recovery operations are to be conducted u.g., a fresh air base (FAB) shall be established in fresh air, as near to the irrespirable zone as safety permits.
2. FAB will be connected by telephone,
   - to surface, if the base is u.g.
   - to shaft bottom, if the base in on surface.
3. Rescue Team shall not proceed beyond FAB, unless the following are available there :
   (a) 2 persons—1 rescue trained person & 1 doctor, if possible.
   (b) A spare team with rescue apparatus, ready to proceed for work.
   (c) One or more reviving apparatus
   (d) F. Aid box, stretcher
   (e) Means of testing for CO
   (f) A hygrometer
   (g) 2 flame safety lamps
4. However, if there is risk of life, rescue team may proceed even if above items are not made available at the FAB. But these shall be made available as soon as possible.

Q. 4. Write a short note on rescue tracing (2005)

Rescue tracing

1. At every u.g. mine, **more than 3** legible tracings of the workings, upto a date not before 3 preceding months shall be kept.
2. Tracing shall show :
   (a) Ventilation system of mine especially
      - direction of air current,
      - air measurement stations,
      - ventilation devices like stoppings, doors, air crossings,
      - booster fan.

   (b) Fire stoppings.
   (c) Preparatory stoppings.
   (d) Location of fire fighting equipment.
   (e) Water dams (with dimensions and other particulars of construction).
   (f) Pumping, telephone and first-aid stations.
   (g) Rooms used for storing inflammable materials.
   (h) Reserve stations.
   (i) Haulage and travelling roadways.
3. In these tracings, signs as per Schedule V of Rescue Rules shall be used.
4. Rescue tracings are meant for use by rescue teams for rescue work.

Q. 5. Write statutory provisions on the following :
Appointment of rescue trained persons in mines, their disposition and accommodation.

Requirement of rescue trained persons/disposition/accommodation

1. At every mine where more than 100 persons are ordinarily employed belowground, atleast 5 rescue trained persons shall be readily available at the surface at any time.
2. If employment belowground is more than 500, 1 man per 100 persons or part shall be rescue trained.
3. Owner shall provide suitable accommodation:
   - to rescue station superintend, instructors and brigade members close to the rescue station.
   - to rescue room incharge, rescue trained persons and attendants attached to it close to the Rescue Room.
   - to other rescue trained persons close to the mine entrance.
4. There shall be an effective bell or other device to call the above persons quickly at time of emergency.

Q. 6. Give an outline of the main equipment used by rescue teams?

Main rescue equipment

Main equipment used by rescue teams are :

1. Breathing apparatus
   (a) Two hours self contained breathing apparatus
   (b) Short duration self contained breathing apparatus
2. Resuscitating apparatus
3. Tube apparatus, bellows type and fan type (i.e. smoke helmet).

Self contained breathing apparatus

These are the main apparatus worn by every member of a rescue team for use for 2 hours at a time. The apparatus is self contained, i.e. it is independent of surrounding atmosphere. Oxygen used up by the wearer is replaced from an oxygen cylinder, and the unwanted CO_2 of the exhaled air is absorbed simultaneously by a regenerating chemical. The apparatus currently used in India are BG-174 (of Draeger). Proto apparatus used earlier for many years is obsolete and not manufactured now. A recent addition in India is BG-4 a modification of BG-174. [BG-174 was introduced in India in 1992 & BG-4 in 2002]

Short duration self contained breathing apparatus

These are used mainly for inspection purposes. They are light weight self contained apparatus. Example : Travox-120, which in similar to BG-174.

Resuscitating apparatus

These are used by rescue teams for mechanical artificial respiration of person whose breathing is affected. A rescue team generally carries only one such apparatus for being applied to victim who is being brought out from irrspirable atmosphere. It is also used at the fresh air base. Example : Maxaman, Pulmotor.

Tube breathing apparatus (or smoke helmet)

It is a sort of helmet. Oxygen to wearer of the apparatus is supplied through a short length flexible tube (36 to 50m in different models) from a place of fresh air, by operating bellows or a fan. It is used for rescuing a man from irrespirable atmosphere, for opening ventilation doors in smoke laden air, for fire fighting etc. The apparatus can be used by ordinary men, under supervision and with a little instruction.

[Resuscitating apparatus and smoke helmet are deseribed in some detail in a separate question—see pages ahead.]

Q. 7. Write statutory provisions on :
Use, supply and maintenance of self rescuer.
(2000, 2003)

Use, supply and maintenance of self rescuers

1. No person shall go into, work or be permitted to go into or work, in any belowground mine unless he is provided with and carries with him a self-rescuer of approved type.
2. If such rescuer
   - is accidentally damaged during use, or
   - goes out of order, or
   - becomes inserviceable due to gaining weight beyond the specified limit or due to having exceeded its specified life, or
   - has been used,

the owner, agent or manager shall immediately replace the self rescuer.

3. The owner, agent or manager of every mine shall
   (a) keep sufficient stock of self-rescuers so that they are readily available whenever needed,
   (b) provide adequate arrangements at the mine for cleaning, maintenance and inspection of self-rescuers,
   (c) ensure that every person is trained in the use of self-rescuer.

Q.8 Write a short note on:
Chemical (oxygen) type self rescuer. (2005)

Or

Write a short note on :
Self contained self rescuer. (2008)

Self contained self rescuer (SCSR)

Self rescuer is an escape apparatus for saving own life while escaping from the mine through toxic atmosphere or atmosphere containing very low % of O_2 after a fire or explosion in the mine.

Self contained self rescuers are close circuit apparatus. The wearer does not have to depend on outside atmosphere. There are two types: in compressed O_2 type O_2 consumed in inhalation is replaced by compressed O_2 supplied by O_2 cylinder of the self rescuer. The chemical type contains a chemical (Potassium Peroxide) which on action by CO_2 and moisture of exhaled air produces O_2 for inhalation.

As per the regulations, every person entering the mine is required to carry a sealed SCSR attached to his cap lamp belt. After explosion or fire in the mine, the wearer breaks the seal of SCSR, dons the self rescuer, fits its mouth piece in the teeth and closes his nose with nose clip. SCSR provides O_2 for 30 minutes for escaping from the toxic atmosphere of the mine.

Persons required to carry self rescuer shall be given training/refresher training in use of self rescuers.

A typical SCSR (Draeger Oxyboks-K) has a heat exchanger also for cooling the inhaled air. It weighs 2.1 kg.

Note : Before 2008, filter self rescuers were used, but, these have since been banned because they could be used only when O_2 in atmosphere was not less than 17% and CO not more than 1%. Now, only SCSRs are to be provided and used.

Q. 9. Write short note on :
(a) Smoke helmet
(b) Resuscitating apparatus.

Smoke Helmet

It is a tube breathing apparatus whereby air is supplied to the wearer through a flexible hose from a point situated in fresh air. It is used for (a) rescuing persons from irrespirable air, (b) opening ventilation doors in smoke laden air, (c) fire fighting and (d) other recovery work within the range of the apparatus.

The apparatus consists of a raw hide helmet having mica eye pieces in an aluminium frame. Helmet totally covers the head of the wearer and is provided with a flexible hose of 25mm internal dia and 50m long (36m in case of Draeger model). Air is forced through the pipe by hand or foot driven bellows or fan worked by a second person in fresh air who also keeps a check for oxygen with flame safety lamp, and birds or approved apparatus for detection of CO. The exhaled air passes out from the helmet via a loose joint around the shoulder of the wearer. A signal rope is spread by the user along with the hose. Before commencing work, signalling code is decided.

Bellows or fan should be continuously operated until the wearer of the smoke helmet does not return to the fresh air base (FAB).

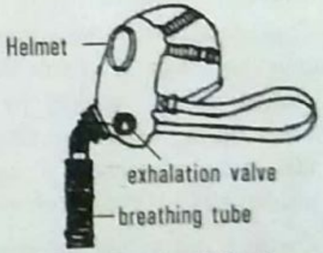


Fig : **Smoke Helmet**

Limitations :
1. The hose may be cut or flattened by fall of roof causing danger to the wearer.
2. Air hose may get entangled preventing retreat of the wearer.
3. No other escape route is feasible in the event of roof fall blocking the path way of the wearer.
4. It can be used upto a distance of only 36m or so from FAB.

Rescue Rules require provision of 2 smoke helmets in every

Rescue Room and atleast one on surface of the mine where there is no Rescue Room.

Resuscitating Apparatus

Resuscitating apparatus is used to administer oxygen to (1) An unconscious person, (2) One who is affected by noxious gases, (3) One whose breathing is feeble due to electric shock or some other cause, (4) Accidental burial under debris, drowning, suffocation.

Manual methods of artificial respiration have limitations : (a) Method cannot be used in atmosphere containing noxious gases, (b) First-aider may get quickly tired, (c) Artificial respiration may not be uniform. Hence resuscitating apparatus was developed.

Well-known equipment are : Maxaman (of Siebe Gorman)

Pulmotor (models PT-60 & PT-61) (not manufactured now)

Oxylog (Draeger)

Novox–widely used earlier, but obsolete and not manufactured now.

Maxaman Resuscitator

This apparatus blows oxygen (or if required, oxygen and air) into the lungs of victim during inspiration phase; used air is sucked out or expellod by action of respiratory muscles and lungs during expiration phase. The apparatus has a capacity of 600 ltrs and weighs 9 kg. Functions are automatic. If air passsage is not free, it gives indication.

Owing to its weight and size, only one apparatus can be carried by the rescue team. It can supply oxygen for about 30 minutes, this limits the distance upto which the apparatus can be used beyond the fresh air base.

Q. 10. What is the minimum equipment to be kept at the surface of a mine where no rescue room is located close to mine entrance? (1993)

Minimum rescue equipment to be kept at surface of a mine

If no rescue room is located close to a mine, the following minimum equipment is required to be kept at the entrance of the mine :

1. Pressure type tube apparatus (smoke helmet) with bellows
2. Flame safety lamp (with maintenance tool kit)
   CO detector, CO tubes
   Whirling hygrometer
3. Safety belt
4. First-aid box, blankets, folding stretcher.

Q. 11. A workman has inadvertently entered an irrespirable atmosphere and fallen unconscious, the oxygen content having been reduced by excess of methane. As overman incharge of the district, how will you save him?

Rescue of a man from air deficient in oxygen

1. No person shall be allowed to rush to rescue the man, because he may also fall unconscious.
2. The overman along with two workers of strong physique shall don self rescuers and bring out the victim to fresh air.
3. Simultaneously arrangement shall be made to fetch stretcher and first-aid box. A responsible man shall be put to inform the manager of the mine over phone regarding the incident and to send for the rescue team.
4. As soon as victim is brought to fresh air, artificial respiration shall be applied and continued until he recovers. If the victim has difficulty recovering, resuscitation apparatus brought by the rescue team shall be put to use.
5. Victim shall be transported to surface for medical aid.
6. A report of the accident shall be written at the end of shift.

Q. 12. Write a short-note on Rescue Station, and Rescue Room with Refresher Training.

Rescue Station

Rescue station is established for serving the needs of all mines belonging to one company in a coalfield.

Rescue station has facilities for :

- Storage, assembly, testing, adjustment of apparatus and their speedy transport to mines
- Initial training

- Refresher training
- Attending to major accidents, and supporting Rescue Rooms in case of prolonged rescue and recovery operations
- Providing rescue coverage to mines within 35km.

Rescue station is equipped with 54 sets of self contained breathing apparatus and 18 brigade members.

Rescue room (RR)

1. Rescue room is provided at the mine where more than 100 persons are ordinarily employed belowground, if there is no Rescue Station (RS) within 35km radius.

   However, RR can serve more than 1 mine belonging to the owner within a radius of 35km, provided their total number of persons ordinarily employed belowground does not exceed 5000.
2. RR is meant only for storage, assembly, testing and adjustment of breathing apparatus and other equipment.
3. It is provided with 15 self contained breathing apparatus.
4. It is under charge of a RR incharge, and is provided with rescue trained persons as required. Atleast 1 rescue trained person always remains in attendance at the RR.

Rescue Room with Refresher Training Facility (RRRT)

1. RRRT is a rescue room for a group of mines,
   - situated within a radius of 35m, and
   - whose number of persons ordinarily employed u.g. exceeds 5000.
2. It functions as a rescue station, except for imparting initial training in rescue work.
3. It is equipped with 30 self contained breathing apparatus, a brigade of 5 rescue trained persons.
4. It is headed by an incharge.

●

Chapter 29

ACCIDENTS AND ACCIDENT ENQUIRY

Q. 1. Define :

Serious bodily injury	(1999)
Reportable injury	(1998, 2000)
Minor injury	(1992)

Serious bodily injury

Serious bodily injury means an injury which has resulted in, or in all probability will result in the following–

- permanent loss of any part or section of the body, or
- permanent loss of or injury to the sight or hearing, or
- any permanent physical incapacity, or fracture of any bone, or
- fracture of one or more joints or bones of any phalanges of hand or foot.

Reportable injury

Reportable injury means any injury, other than a serious bodily injury, which involves, or in all probability will involve, enforced absence of the injured person from work for a period of 72 hours or more.

Minor injury

Minor injury means any injury other than serious bodily injury or reportable injury, which results in enforced absence from work of the person injured for a period exceeding 24 hours and less than 72 hours.

Note : Accident causing 10 or more fatalities is termed **Disaster**.

Q. 2. What is dangerous occurrence?

Dangerous occurrence

The following occurrences are termed dangerous occurrences–

1. explosion or ignition,
2. spontaneous heating or outbreak of fire, or appearance of smoke or other indications of heating or outbreak of fire.

3. influx of noxious gases,
4. occurrence of inflammable gas in a mine in which it has not been found earlier,
5. eruption of water,
6. instantaneous failure of a pillar, or part of a pillar or several pillars of coal in workings belowground,
7. premature collapse of any part of the workings,
8. accident due to explosives,
9. breakage or fracture of rope, chain, headgear pulley or axle or bearing thereof, or other gear by which persons are lowered or raised,
10. overwinding of cages while men are being lowered or raised,
11. breakage or fracture of an essential part of winding engine, crankshaft, coupling, bearing, gearing, clutch, drum or drum shaft, or failure of emergency brake,
12. bursting of an equipment containing steam, compressed air or other substance at high pressure,
13. breakage, fracture or failure of an essential part of any machine or apparatus whereby safety of persons may be endangered or
14. Sliding of OB dump.

Q. 3. Write statutory provisons on :

- Place of accident not to be disturbed. (2007, 2013)
- Notice of accident. (2008, 2012)

Place of accident not to be disturbed

1. When an accident occurs in or about a mine causing loss of life or serious bodily injury to any person, the place of accident shall not be disturbed or altered before the arrival or without the consent of the Chief Inspector or the Inspector, unless such disturbance or alteration is necessary to prevent further accident, to remove bodies of the deceased or to rescue any person from danger, or unless disontinuance of work at the place of accident would seriously impede the working of the mine.
2. Before the place of accident involving a **fatal or serious** accident is disturbed or altered due to any reason whatsoever, **a sketch of the site**, illustrating the accident and all relevant details shall be prepared (in duplicate). It shall be duly signed by the manager or assistant manager, safety officer, surveyor and the workmen's inspector (or where there is no workmen's inspector, by any workperson present at the place of accident). Such sketch shall also be supported by **photographs** of the place of the accident.

   If the place is disturbed or altered to prevent further accident or rescue persons from danger before the sketch could be prepared, the same shall be prepared immediately thereafter giving all relevent details as existed before the place was disturbed or altered.
3. One of the authenticated sketches shall be delivered or sent to the concerned inspector of mines.

Notice of accident

See Q. 12 on Page 39

Q. 4. State briefly what is 'accident analysis' and how it helps in reducing accidents. (2010)

Accident analysis

Accident analysis is the systematic analysis of information/facts found by accident site inspection, statements of the injured and his co-workers and supervisors, examination/testing of machinery & tools involved with a view to find out:

(a) The root cause and contributory causes of the accident

(b) Unsafe conditions prevailing at the place of accident

(c) Unsafe acts which aggravated the situation

(d) Laxity in supervision due to which preventive actions were not taken in time.

DGMS has advised that at every mine a systematic record should be kept of all accidents (fatal, serious, reportable and minor) and incidents. These details should be analysed from time to time to ascertain risky physical conditions, risky parts of the mine, risky operations, risky machinery, risky methods of working, lapses in supervision etc., and corrective actions should be taken. Similar accident analysis should be carried out at Area and Company level.

Benefits of accident analysis

Accident analysis helps in taking a variety of corrective actions to prevent accidents:

(a) **Improvement in physical conditions like**

- Dressing of roof/sides
- Ventilation, lighting
- Method of roof bolting
- Slippery floor
- Support at the goaf edge

(b) **Technical measures like**

- Changes in method and periodicity of machine maintenance
- Improvement in quality of safety materials
- Use of safety devices, personal protective equipment
- Fitting guards on dangerous parts of machinery, timely replacement of cables, worn out rope, worn out tub couplings

(c) **Correction of human errors such as**

- Training/refresher training of workers
- Explaining proper work practices and precautions to supervisory staff, making them aware of dangers, making changes in Safe Operating Procedures
- Better supervisory and managerial control
- Drawing attention to dangers by discussion in meetings of Safety Committee.

Q. 5. Assuming your own conditions write a report of an accident due to blasting projectiles in an opencast mine. Point out violations of the regulations. (1993)

Accident due to blasting projectiles in OC mine

The Manager
............O.C.P.

Sub : Serious Accident due to Blasting

Sir,

I am sorry to inform you that to-day (18.8.2015) in my shift (II shift) there has been a serious accident due to blasting.

Particulars of the injured persons

Name : A.K.Anthony
Designation : Shovel E.P.Fitter
Age : 32 years
Job Experience : 8 years
Nature of injury : Fracture Right leg (below the knee)
Time of accident : 1.30 P.M.

The injured person has been admitted in the hospital and his condition is satisfactory.

Description of the accident

Today during the shift-change hours by about 1 P.M. I made all arrangements to blast 18 deep holes in the bottom O.B. bench. I removed all persons from the 500m danger zone to outside (or to safe shelters) and sounded the siren. A.K. Anthony, senior shovel E.P. Fitter with his helper Preetam Singh had insisted and taken shelter in the blasting shelter kept on the top O.B. bench. This was at a distance of about 400m from the place of firing.

However, there was a delay of about 5 minutes in firing as I was not getting the circuit continuity and circuit had to be checked. When the shots were fired, there were shouts and I came to know that a piece of stone weighing some half kg had hit A.K. Anthony in his right leg causing a fracture below the knee.

He was immediately given first aid and sent to hospital in the shift van.

It was learnt from Preetam Singh, E.P. Helper who was with A.K.Anthony, that A.K. Anthony became restless when blasting was delayed, and he went out to look into the blasting area, just then the shots went off.

Place of accident has been marked as also the stone that hit him.

I am sorry. I know there has been a violation of regulations. In future I shall not permit any person to be in the shelter also.

Further I shall advise all persons not to leave their place of safety until they hear 'all clear' signal even if there is a delay.

18.8.2015
4.30P.M.

Yours faithfully
Signature
(ABC)
Blasting Overman

Note : A.K. Anthony did not obey the safety instructions. This is also a violation of regulations (Duties of persons employed in mines).

Q. 6. A shotfirer helper received serious injuries due to blown-through shot in development workings of an underground mine. Assuming your own conditions write a report of enquiry into the accident. (1997)

Enquiry Report of Serious Accident due to Blown-through shot

To
The Manager,
X-Colliery

Sub : Serious Accident of Jagdish Singh, Shotfirer Helper on 18.8.2015 (II shift)

Sir,

I am sorry to inform you that to-day (18.8.2011) in my shift (II shift) there has been a serious accident due to shotfiring as given below :

Name of the person injured : Jagdish Singh
Designation : Shotfirer Helper
Age : 24 years
Experience on the job : 4 years
Date and time of accident : 18.8.2015, 10-15 P.M.
Nature of injury : Fracture of left leg below knee
Place of accident : 15EL at junction of 12 Rise
Cause : Blown-through shot.

Jagdish Singh is admitted in hospital and his condition is satisfactory.

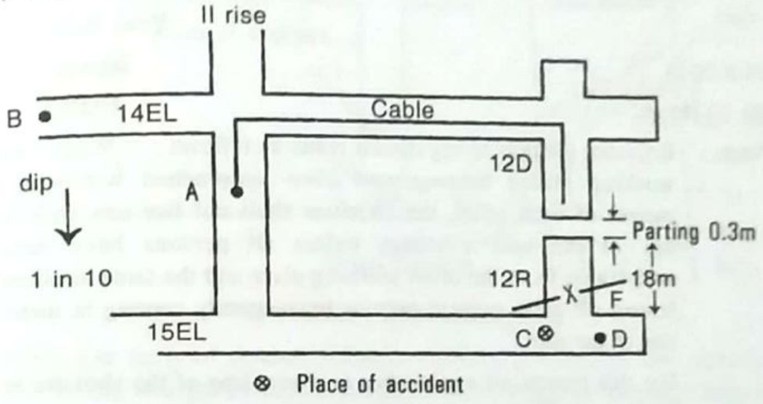
Details

I received information of the accident at about 10-30 P.M. when I was at the pit bottom of No. I pit. I rushed to the site of accident.

Jagdish Singh, Shotfirer Helper, had suffered a fracture of left leg below the knee by a blown-through shot when he was at 12 Rise junction of 15E level. He was fully conscious and speaking. With the help of the section mining sirdar Ram Kripal Singh, I immobilised the fractured portion with splints and triangular bandages, and sent the victim to surface on a stretcher by about 11P.M.

I rang up the attendance clerk to get ambulance at the pit-top.

Inspection showed that 12 dip face had almost joined with 12R face—parting on east side was hardly 0.3m. 12R face had a fencing (F) at the mouth.



A–Shotfirer, B-S.F.Helper, C-Victim, D–Loader

Fig : **Sketch of accident site**

Birju, loader, was an eye-witness to the accident. Enquiries from him, and from the other shotfirer helper (Prabhu Singh), shotfirer (Mahesh Choudhary) and the mining sirdar revealed that 12 holes were charged for blasting in 12 dip face. Cable was laid from the face to place A from where blasting was to be done. One helper (Prabhu Singh) was posted at B.

When the shotfirer went to the face to connect the cable to holes, the other shotfirer helper (Jagdish Singh the victim), went to 15EL to clean 13 holes which had been drilled. Birju carried clay cartridges to the face. When they were coming out, 12dip face was blasted, and a blown-through shot hit Jagdish Singh in his left leg, and he fell down (at place C in the sketch.)

Accident occurred at about 10-15 P.M.

Cause and responsibility

1. The accident occurred due to blown-through shot as victim was in a place of danger. The shotfirer did not inspect this side. He also failed to ensure that no body could come in direct line of the shot.
2. The Mining Sirdar put the fencing in incorrect place.
3. Wrong position of fencing did not occur to me also. This was due to my ignorance.

I may kindly be excused for my failure. I shall take due care in future.

Note : The place of accident has been fenced for inspection and enquiry.

Your faithfully
Signature
(ABC)

19.8.2015
00-30 Hours

Note : Relevant portion of regulation reads as follows : " When two working places belowground have approached within 4.5 metres of each other, the shotfirer shall not fire any shot in any of the said workings unless all persons have been withdrawn from the other working place and the same has been fenced off as to prevent persons inadvertently coming in direct line of the shot."

For this reason all approaches in direct line of the shot are to be fenced off..

Q. 7. A fatal accident by fall of roof has occurred in a development face. Assuming your own conditions write a report of enquiry into the accident. (1997)

Enquiry Report of fatal accident by roof fall in development workings

To
The Manager,
X-Colliery

Sub : Enquiry report of fatal accident of Birju, loader on 13.8.2015

To-day (13.8.2015) at about 8 P.M. when I was in 20W section I received information of accident in 20E development section in which one loader was involved. I rushed to the site.

Birju, loader, had been injured by roof fall in 19R of 20EL. With the help of workers, mining sirdar Jamuna Singh had removed the stones and brought out Birju to a level place. I saw Birju was unconscious and his breathing was weak. From the position of the body, it appeared that he had received severe injury in the back.

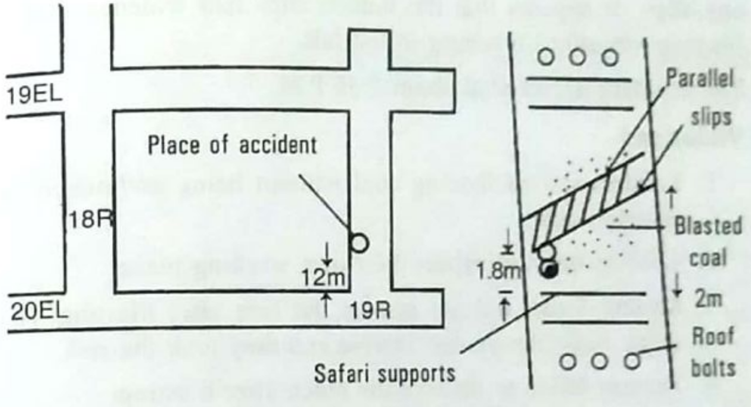


Fig : **Sketch of accident site**

With the help of rescue trained workers present in the district, the victim was given first aid. I quickly arranged to transport him to surface on a stretcher, with 6 extra bearers and with mining sirdar Jamuna Singh as escort.

I rang up the attendance clerk to get ambulance, and to inform you and the doctor.

Enquiry

Inspection of the site showed that a mass of sandstone about 5m × 2.5m × 0.3m had fallen from a height of about 2.5m. It had separated from two parallel slips.

Statements of mining sirdar (Jamuna Singh), shotfirer (Bhola Singh), loaders of the gang (Babban Singh and Pawan Singh) and dresser (Mangla Majhi) indicated that 12 holes were blasted solid in the 19R face (of 20L). It joined with the 19 dip face of 19EL which had been kept stopped and fenced due to parting being less than 4.5m. After dressing of roof and side by Mangla Majhi, the loaders of Birju gang started loading coal. They had hardly loaded 5-6 baskets when the mass of roof came down without warning.

Dresser had not noticed the slips. The mining sirdar, who was busy supervising roof bolting in 15EL, did not inspect the face after blasting. Shotfirer inspected the face but he did not inspect the roof and sides minutely as he thought it would be inspected by mining sirdar.

I had been to the face in beginning of the shift but did not notice any slips. It appears that the hidden slips had widened due to blasting vibrations resulting in the fall.

The accident occurred at about 7.35 P.M.

Violations

1. Loaders started loading coal without being authorised by mining sirdar.
2. Loaders did not inspect their own working place.
3. Mining Sirdar did not inspect the face after blasting. His delay made the loaders restive and they took the risk.
4. Dresser failed to observe the crack after blasting.

Place of accident has been fenced off.

On reaching surface, I came to know that Birju unfortunately died on way to the hospital.

Summarised particulars

Name of the injured : Birju
Designation : Loader
Age : About 30 years
Experience on the job : About 8 years
Type of accident : Fatal due to injuries in back bone.
Date and time of accident : 13.8.2015; II Shift, about 7.35 P.M.
Place of accident : 19th rise of 20 EL of 20E section.

14.8.2015
00.30 Hours

Yours faithfully
Signature
(ABC)
Overman

Q. 8. Write a report of an accident where a spotter was run over by a dumper while reversing. Assume your own conditions. (1998)

Fatal accident of spotter (dumpman) by dumper

The Manager
Ghanshyam OCP

Sub : Fatal accident of Lakhan, spotter, by dumper on 6.8.2015

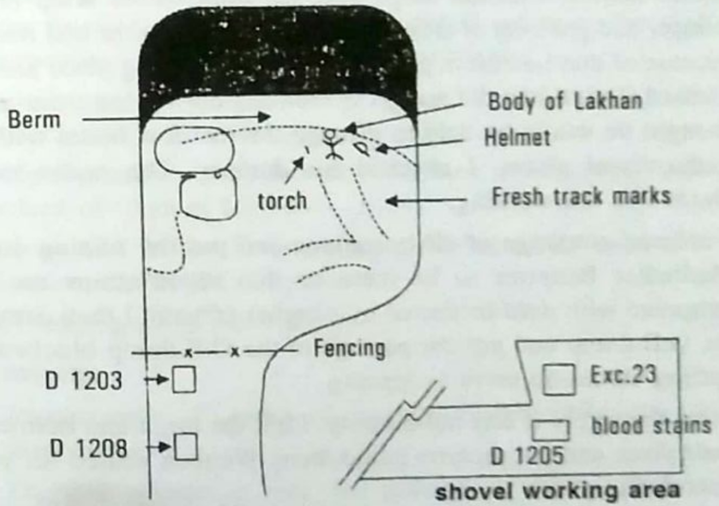
Sir,

My written report about fatal accident of Lakhan spotter (Dumpman) in 3rd shift of 6.8.2015 by reversing 85t dumper D 1205 in the O.B.dump is as follows :

Accident

On 6.8.2015 in the 3rd shift (8.30 P.M. to 4.30 A.M.) I was working as overman in Ghanshyam OCP. Work was being done in OB with 8m^3 shovel Exc.23 and 3 nos. 85t dumpers D1203, D1205 and D1208. Everything was normal upto tea break (oo-30 to 1-00 Hrs.), after which operations recommenced at about 1-05 Hrs.

At about 1.35 A.M. when I was near the O.B. Shovel, dumper D1203 which had been loaded some time back returned to the shovel area and its operator Gyan Singh informed me that spotter Lakhan was lying dead in the O.B.dump. I rushed to site of accident by his dumper and in the focus of headlight of dumper, I saw the body of Lakhan resting against the berm of the O.B.dump, with chest and face badly crushed—almost beyond recognition. His helmet and torch were lying on the ground by his side. There were fresh trackmarks of dumper near his body. It became immediately clear that he had been crushed by a dumper.



Sketch of accident site

Soon dumper D1208 (operator Hanuman Singh) also reached the O.B. dump with load.

On my walkie-talkie I asked the view point to inform the manager.

Cause

There were only 3 dumpers working so I had a doubt that Lakhan might have been killed by D1205 which was being operated by dumper operator Makhan Singh. I went to the shovel area–this time by dumper D1208 of Hanuman Singh. D1205 was almost loaded. I asked its operator Makhan Singh whether Lakhan was injured by his dumper. He denied. On further enquiry he said he had unloaded only one trip in the dump and when he went for dumping, he did not find Lakhan in the OB dump, and he dumped the OB by himself. As I had a doubt, I examined the backside of the dumper—the dala (body) showed fresh blood stains. Makhan Singh was susprised to see the marks. I showed the blood stains to mining sirdar Madhukar Banerjee, shovel operator Kailash Yadav and cableman Narain. On further enquiry Makhan Singh said, the audio-visual lamp of his dumper had gone out of order a little before the tea-time and may be because of that Lakhan might have gone in the wrong place and got crushed. He said he did not get it repaired during tea-time as he thought he would be able to manage the rest few hours without audio-visual alarm. I checked his dumper. The audio-visual alarm was not working.

I ordered stoppage of all operations and put the mining sirdar Madhukar Banerjee to be there so that blood stains are not tampered with until inspected by a higher official. I then came to the O.B.dump and got the passage to the O.B.dump blocked by putting stones–to serve as fencing.

I saw the torch. It was not burning. I left the torch and helmet in their place and put security guard there. We then waited for your arrival, Sir.

Analysis and Findings

Audio-visual alarm of dumper D1205 was not working. Torch of the spotter Lakhan was not burning. His body was lying in O.B.dump with crush injuries. There were blood stains on backside of dala (body) of dumper D1205, Its operator Makhan Singh says he did not see the spotter in O.B.dump when he went there with his first load after tea time.

It appears that since the audio-visual alarm (and its light) was off, Makhan Singh could not see Lakhan in the darkness. As there was nobody, Makhan Singh would not have blown his horn also. Some how Lakhan, not getting any alarm, might have got confused in darkness and gone in the wrong place, and unfortunately got crushed by the reversing dumper D1205.

The time of accident could be about 1-20 Hrs.

Thus the findings show that on 6.8.2011 in the 3rd shift, at about 1.20 Hrs, spotter Lakhan met with a fatal accident by reversing 85t dumper D1205 in the O.B. dump, while it was being operated by dumper operator Makhan Singh.

Responsibility

1. Dumper operator Makhan Singh is responsible for causing the accident by working the dumper without audio-visual alarm and reversing his dumper carelessly without blowing the horn. He did not report the defect either to the shift supervisor or to the shift auto-electrician.
2. Shift auto electrician Shivji failed in his duty by not checking the dumpers properly during tea time.

Contributory causes. (1) Absence of lighting in O.B.dump area. (2) Failure of torch of Lakhan.

Violations of CMR : (1) Operating the dumper without audio-visual alarm : violation of bye-laws.

(2) Not keeping dump area lighted

Suggestions

1. Engagement of spotter (dumpman) in the dump may be discontinued.
2. Dumper operators may be trained to dump without spotter. On entering dumping area, dumper operator shall visually check the area of his operation and back his dumper carefully in the area visually inspected to rest against the berm. The berm may be about half the wheel diameter in height.
3. Between sunset and sunlight dumping area should be kept well lighted.
4. No dumper should be operated if audio-visual alarm is not working.

5. A foreman (excavation) or JET (Excavation) may be posted in the night shift for supervision of equipment.

7.8.2015
8.30 A.M.

Yours faithfully
Signature
(ABC)
Overman

Note : 1. Note the care taken by the overman to preserve the evidence. Accident area is not disturbed.

2. As per the regulations, in case of fatal or serious accident, the place of accident is not to be disturbed or altered before the arrival or without the consent of the Chief Inspector or the Inspector. However, it does not prevent alteration necessary to prevent further accident, to remove dead bodies or to rescue any person in danger, but in that case a sketch of the site is to be prepared and a photograph taken, a copy of which will be given to the Inspector.

3. From the above report, you might have noted the procedure of conducting enquiry and writing the report as follows : Receipt of information; rushing to the site of accident; noting position of victim; (rescue, first aid and transport); intimation to surface and manager/undermanager.

Minute observation of site; enquiry from eye witnesses or circumstantial evidence as to what the victim was doing before the accident occurred; role of supervisor; cause; contributory causes; responsibility; violations; suggestions to prevent recurrence.

Q. 9. Write a brief report of a fatal accident caused by direct rope haulage in an underground mine. Assume your own conditions. (April 1999)

Report of accident due to haulage

To
The Manager
X Colliery

Sub : Report of fatal accident of Jumman Mia, Explosive Carrier, in I shift of 10.8.2015

Sir,

Further to my intimation over phone about fatal accident of Sri Jumman Mia, I am to report as follows–

Today in I shift at about 2.45 P.M. while I was in 28E section, I received information of an accident in the haulage incline. I rushed to the site of accident.

About 15 metres above 18WL in the haulage road, near a manhole, I saw Jumman Mia lying unconscious. His right leg was pressed under a derailed coal tub and it was bleeding. There were 4 other derailed tubs coupled to it and coal was lying scattered. Jumman Mia was breathing normally.

With the help of Ramoo Mahto, looseman, Ajoy Mukherjee, mining sirdar and some others, he was rescued by lifting a corner of the coal tub. After dressing and bandaging with splints, he was sent up on the stretcher. I gave 4 extra stretcher bearers and sent the mining sirdar to escort.

I rang up the attendance clerk to get ambulance, and to inform you and the under manager K.P. Banerjee.

Later on coming to the surface, I learnt that Jumman Mia died on way to the hospital.

Enquiry

I made enquiries from the victim's co-worker Kewal Prasad, explosive carrier, who was coming up with him, and from the looseman, Ramoo Mahto, who had connected the tubs to the rope. After inspection, the side has been fenced on either side.

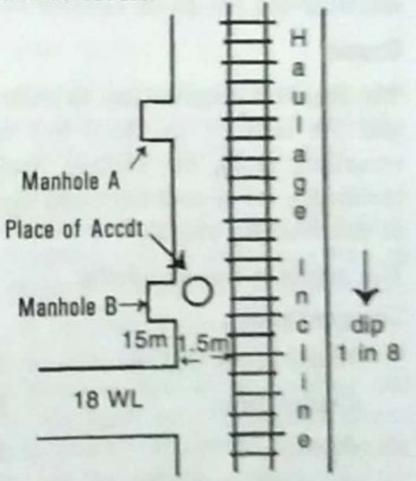


Fig : 1 Sketch of accident site

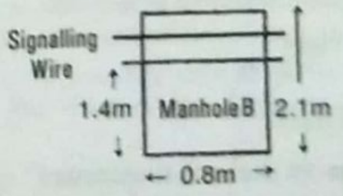


Fig : Signalling wires blocking manhole B.

The accident appears to have occurred as follows :

After completing blasting Bimal Ghosh, shotfirer, came up by the haulage incline. His helpers followed but slowly. When Kewal Prasad was near 17WL, he heard loud sound of running down of coal tubs. He rushed into the adjacent manhole ('A' in the sketch). He also saw Jumman Mia approaching next manhole ('B' in the sketch) but before he could get in, he was hit by the derailed tubs.

On inspection of the manhole, signalling wires were seen obstructing it. This might have delayed Jumman Mia's entry into the manhole.

Tub coupling between 4th and 5th tubs was found broken. Total number of tubs attached
to the rope did not exceed the fixed maximum (8), but no drag was seen attached to the set. Track showed that tubs ran uncontrolled for about 2 pillars before getting derailed.

Cause

The accident occurred due to failure of tub coupling between 4th and 5th tubs (it has been left in place for inspection), men travelling along the haulage road, not using drag behind the ascending set of coal tubs, and signalling wire obstruction acted as contributory causes.

The accident was avoidable.

To summarise :

Name of the injured : Jumman Mia
Designation : Explosive Carrier
Age : 24 years
Experience on the job : 4 years
Date and time of accident : 10.8.2015; 2.30P.M.
Place : Haulage Incline about 15m above 18WL
Cause : Failure of tub coupling

Steps to prevent recurrence

1. All tub couplings may be checked thoroughly. The system of checking may be reviewed.

2. Signalling wires to be lifted at manhole 'B'. All other manholes to be checked for similar obstruction.
3. Looseman Ramoo Mahto has been warned for not using drag. An eye is to be kept on his work.
4. Shotfirer Bimal Ghosh deserves to be issued severe warning for travelling along the haulage roadway and for creating a wrong example for his men.
5. Possibility of keeping the travelling roadway all along in the intake is to be explored to prevent temptation of travelling along the cooler haulage roadway.

4.30 P.M. Yours faithfully,
10.8.2015 Signature
(ABC)
Overman

Note : 1. In the examination, the candidate should not sign his name.

2. Note the finer points of the report :

The overman has brought out name, designation, age and experience of the victim; date, time and place of accident; job that the victim was doing just before the accident.

On hearing of the accident, overman rushed to the site of accident, rescued the victim, noted his condition, gave first-aid, and arranged for transport, rang up attendance clerk to get ambulance, and to inform the manager and undermanager.

He examined place of accident minutely; saw broken coupling, counted no. of tubs. He enquired from the eye witness and found out the cause-breakage of coupling, but he did not stop at that. He found out contributory causes leading to the accident by finding out why the injured could not enter the manhole, and the non-use of drag. He even found failure of the supervisor (shotfirer). He has indicated names of persons who may be needed for detailed enquiry. He kept track of injured person's condition.

He gave a sketch of accident site. The place of accident has not been disturbed. The coupling has also been left untouched.

Overman is not supposed to remember serial no. of the regulation. Hence he has not given the same in his report but he has given the facts all right. He has given preventive steps also.

The report has been written promptly, and he has not forgotten to give date and time of writing the report.

3. Details of violations of CMR 1957 are given below to refresh the memory :
    (i) *Not using drag* is a violation of Reg.87(3) (c) which states that an attachment of backstay or drag shall be used behind an ascending tub or set or train of tubs, for preventing their running back.
    (ii) *Use of defective coupling* is a violation of Reg. 89 (1) (c) according to which the attachment between a rope and a tub or set or train of tubs and the attachment between any two tubs in a set or train, shall be so maintained as to obviate accidental disconnection.
    (iii) *Manhole not kept clear of obstruction* is a violation of Reg. 87 (6)(c) according to which every manhole shall be kept clean and clear of obstruction.
    (iv) *Travelling by haulage road* is a violation of Reg. 88(3) which states that except for purposes of inspection, examination or repair, every person other than an official or a haulage attendant shall travel by the travelling roadway.

Q. 10. Write a report of a serious accident of trammer.

Serious accident of trammer during coupling of tubs

To
The Manager,
X-Colliery

Sub : Serious Accident of Lallan Singh, Trammer, in I shift of 8.8.2015

Sir,

I regret to inform you that to-day in I shift (my shift) there has been a serious accident as given below :

Name of the person injured : Lallan Singh
Designation : Trammer
Age : About 25 years
Experience on the job : About 2 years
Type of accident and nature of injury : Serious accident; about half portion of left hand little finger cut off.

Date and time of accident : 8.8.2015, about 2.30 P.M.
Place of accident : Zero cross cut section; at junction of zero cross cut and 24th level.
Cause : During coupling of coal tubs.

At about 2.45 P.M. while I was in 28 East section, I received information of accident in the zero cross-cut section. I rushed to the site.

About half inch portion of left hand little finger of Lallan Singh, Trammer, was cut off while he was coupling two tubs. Deepak Majoomdar, mining sirdar, had dressed the little finger of Lallan Singh. Being a healthy young man, he was able to bear the pain. He was fully conscious and could walk. He was sent upto surface with 3 escorts. He could speak and tell how he got injured.

I rang up the Attendance Clerk to keep amublance ready at No.1 incline mouth, to inform you and intimate the hospital.

Enquiry

In addition to what Lallan Singh said, I enquired about the accident from trammers and signalman. Accident occurred as follows :

There was a set of 4 loaded tubs in 24th level at zero cross cut junction. The front or first loaded tub was coupled with the haulage rope of 50 h.p. haulage of No.1 incline by Ramanand Singh Trammer, 2nd and 3rd loaded tubs were coupled by Jagdish sao, Trammer and 3rd to 4th loaded tubs were coupled by Ramoo Mahto Trammer.

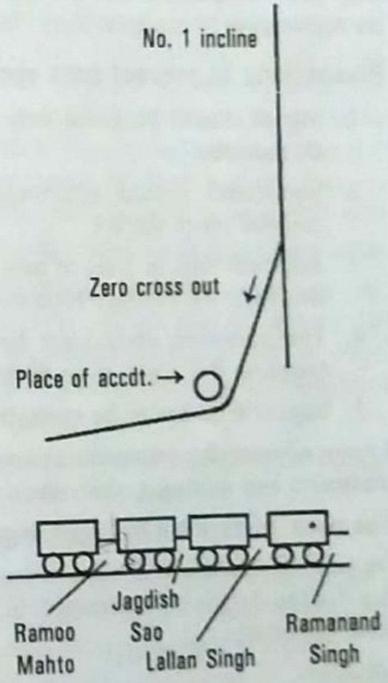


Fig : **Site of Accdt.**

Lallan Singh was coupling 1st loaded tub with the 2nd tub. The other three trammers were just holding the sprags inserted into the wheels of the last 3tubs. While still in the process of coupling, Lallan Singh shouted to Ambika Singh, Signalman to signal to raise the set. The signal-man gave 4 raps to raise the set. As soon as the haulage rope was tightened, Lallan Singh shouted loudly. Ambika Singh stopped the haulage by giving one rap. With the rope getting loosened, Lallan Singh was able to pull out his hand but about half inch portion of his left hand little finger was cut—the cut portion was just hanging by the muscles. Actually Lallan Singh shouted to give signal for raising up the set of tubs while he was still in the process of coupling up. While tightening the bolt of the coupling, the rope got tightened, his little finger got caught into the coupling and thus the was injured.

Lallan Singh himself accepted his mistake that he was wrong in expecting that he would be able to complete the work of coupling before the rope was tightened.

Inter-shift competition due to on-going production drive prompted the trammers to be in a great hurry. This has been a contributory cause.

Precautions to prevent such accidents

1. Signal should be given only after completion of coupling all the tubs.
2. Signalman should positively confirm that all tubs are coupled up in the set.
3. Adjacent tubs in a set of tubs should be coupled up before attaching the haulage rope to the front tub in the set.
4. The trammers should not be in too much of a hurry in coupling the tubs—even during production drive period.
5. Supervision has to be strengthened.

I have advised the trammers accordingly and shall advise other trammers and mining sirdars also.

The place of accident has been fenced up for further enquiry.

On coming to surface, I came to know from the attendance clerk that Lallan Singh was admitted in the hospital and he was in good condition.

8.8.2015 Yours faithfully

4.30 P.M. Signature

(ABC)

Overman

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Chapter 30

PERSONAL PROTECTIVE EQUIPMENT

1. Safety helmet

- Every person entering a mine–u.g. or opencast, or siding, CHP, workshop is required to wear DGMS approved safety helmet all along. Dumper operators and loaders carrying baskets as head loads are also required to wear helmets.
- Helmets are given free of cost, once in 3 years to u.g. workers and once in 5 years to opencast workers.
- The lining is replaced once in 6 months. It is an important part of helmet. When helmet is hit by an object, the lining with its gap from helmet bears the shock and protects the head from injury. It should be washed atleast once in 30 days in warm soapy water and then rinsed. Helmet should be used with its strap to prevent it from falling off. Helmet is provided with holes for ventilation, and a hook for fixing safety lamp.
- Helmet protects the head which is the most important part of the body. It gives protection against falling rock/coal pieces, blasting projectiles etc. It also protects when the wearer slips and falls or his head strikes against a girder etc.
- Management is to maintain sufficient stock to ensure immediate supply as and when required.

2. Safety shoe, boot & gum boot

- The regulations require that no person shall enter a mine (u.g. or O/C) without wearing approved safety footwear. Footwear shall be supplied free of charge.
- Safety canvas shoes are given to workers of u.g. mines once in 6 months.
- Trammers, *tyndals* and persons working in slippery places are provided with leather shoes once every year.

Female workers engaged in surface operations and quarries are provided with special type of footwear.

- Foot wear protects the toes, which are vulnerable to injury, from falling lumps of coal and rocks or injury by supports or rails etc. They also protect against skin diseases.
- Gum boots are provided to persons working in watery and muddy places, once in 3 years.

3. Hand gloves

Persons engaged in electrical work, cablemen, *tyndals*, trammers, welders are exposed to hazards of injuries to hand. They are provided with hand gloves of appropriate type. Gloves for protection against electricity should be of tested type bearing ISI mark. Hand gloves should be of correct size for comfort and ease at work.

4. Safety goggles & welding shields

Welders are provided with goggles and welding shields fitted with un-splinterable glass for protection against sparks and harmful rays of welding. Goggles are given to persons working on lathe, cutting and grinding machines. At places, face shields are also provided.

5. Dust respirators

Where, inspite of all steps taken to prevent formation and suppression of dust, concentration of dust exceeds permissible limits, workers are to be provided with dust respirators of approved type. They filter the air of dust particles. They are essential for drill operators, dozer operators, continuous miner operators etc. Management is required to provide means for regular cleaning/disinfecting and maintaining dust respirators in efficient working order, and thorough training to workmen in correct use.

6. Ear plugs and ear muffs

Where, inspite of all measures noise cannot be reduced within permissible limits, as in case of dozer operators, drillers, bunker chute operators etc., workers are provided with ear plugs or ear muffs to prevent injury to hearing.

7. Shin guards

Padded shin guards are provided to workers working in

longwall faces of low height or other places where the height is limited and workers have to work or crawl on their knees.

8. Self rescuers

- Self rescuer is an escape apparatus for saving own life while escaping from the mine through toxic atmosphere or atmosphere containing very low % of O_2 after a fire or explosion in the mine.
- Self contained self rescuers are closed circuit apparatus. The wearer does not have to depend on outside atmosphere.
- As per the regulations, every person entering the mine is required to carry a sealed SCSR attached to his cap lamp belt. In event of an explosion or fire in the mine, wearer breaks the seal of SCSR, dons the self rescuer, fits its mouth piece in the teeth and closes his nose with nose clip. SCSR provides O_2 for 30 minutes for escaping from the toxic atmosphere of the mine.

9. Safety belt

- When a person cannot be protected against fall from a height by other means, management is required to provide an approved safety belt, suitable for the hazard. It is attached by means of a lifeline to a fixed anchor, and adjusted to allow a drop not more than 1.8m in case of a fall.
- Safety belts are used by workers employed in awkward positions where they may lose balance or support and fall from height. Such operations may be,
  - Dressing and repairing of shafts
  - Fitting and dismantling pipe ranges, cables, buntons in the shaft.
  - Dressing of quarry sides
  - Repair of head gear
  - Work on electric poles etc.
- Safety belt should bear BIS certification mark. It should be maintained properly and checked every time before use.

- Whenever a safety belt is used, atleast one other person should be present.

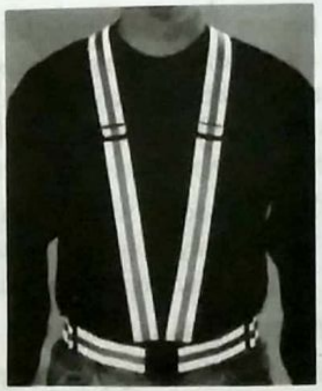
10. Safety overalls

In high speed sinking watery shafts and in some other difficult places in the mine, workers are provided with safety overalls.

11. Visibility harness

- Where it appears to the Regional Inspector that a class of persons working in a mine in exposed to undue hazard, such persons are to be provided (free of charge) visibility harness for being spotted at a distance in the dark.
- One type of visibility harness is shown in the figure. It consist of 4cm fluorescent lime yellow or orange elastic with silver stripes on vest and shoulders straps, a quick release snap-on buckle in front and adjustable to fit different sizes.

(Ref : Cir. Legis. 1/2008)



- In some opencast mines in our country, field workers have been provided with orange coloured jackets for use after daylight hours.

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Chapter 31

MINES ACT 1952 & MINES RULES 1955

Q. 1. What are the statutory provisions in respect of Workmen's Inspector? Describe the duties of Workmen's Inspector.

Workmen's Inspector

1. Designation

(i) In every u.g.mine of manpower 500 or more, and

(ii) In every mechanised o/c of manpower 100 or more,

the owner, agent or manager shall designate 3 employees as Workmen's Inspectors one each from mining, mechanical and electrical discipline—in consultation with the largest recognised trade union.

If manpower is more than 1500, one additional WI (mining) shall be designated.

Substitute WI shall also be designated— one from each of the three disciplines.

2. Qualifications

Mining :	Overman's certificate
Electrical :	Electrical Supervisor's certificate
Mechanical :	Status equivalent to overman

Experience– 5 years experience of mines including 2 years in the same mine.

3. Facilities

(i) Management shall permit WI to inspect the mine any time.

(ii) WI shall be informed when there is an accident or dangerous occurrence.

(iii) WI shall work as such for 2 days in a weak, on other days he will do his normal work.

(iv) WI shall be given 30days orientation training.

(v) Tenure of WI shall be 3 years.

(vi) No disciplinary action shall be taken against WI for pointing out defects.

4. Duties

1. To inspect all shafts, inclines, roads, workplaces and equipment thereat, including equipment for transport of workmen.
2. To inform the Manager and the Inspector if WI notices any urgent and immediate danger, and to suggest remedial measures to avoid the danger.
3. To accompany the Inspector in his complete inspection of the mine, and also in any other inspection if considered necessary by him.
4. To investigate into accident/dangerous occurrence on getting information from management.
5. To record results of his inspection in Form U and furnish the same to the Manager.

5. Action on report of WI

Within 15 days of WI writing the report, the owner, agent or manager shall put remarks in form U showing remedial measures taken with date on which the action was taken.

Note : Earlier WI were for u.g. mines only. On recommendation of National Safety Conference, WI are nominated now in o/c mines also.

Q. 2. Write a short note on Workmen's Inspector. (1994, 2001, 2010)

Note : In a short note, it would be sufficient to write points (1), (2) and (3) above, and mention "WI shall carry out duties as prescribed in the Mines Rules."

Q. 3. Write the statutory provisions on :
'Action on the Report of Workmen's Inspector'. (2004)

Note : See point (5) of Q. 1 above.

Q. 4. Write the statutory provisions for constitution of safety committee. What are its functions? (1999)

Write a short note on Safety Committee. (2011)

Safety Committee

In mines employing more than 100 persons, the owner, agent or manager shall form a safety committee (SC). However, a joint SC may be formed for a group of mines by a general or special order from the Chief Inspector or Inspector under certain conditions.

Composition of SC

SC shall consist of

- manager, to act as chairman,
- 5 officials or competent persons nominated by the chairman,
- 5 workmen nominated by the largest Trade Union,
- Workmen's Inspectors.
- safety officer to work as secretary of SC.

The chairman may co-opt any other official or competent person for a particular day or days of the meeting.

Functions of SC

1. Discuss remedial measures against unsafe conditions and practices pointed out by WI or otherwise.
2. Discuss proposed safety and health measures before
   (a) opening of a new district,
   (b) starting a new mechanical or electrical installation,
   (c) introduction of new mining technique.
3. Discuss accident enquiry report and make proper recommendation.
4. Formulate and implement safety campaign based on accident analysis.
5. Meet at least once in 30 days to consider the matters of safety placed before it.
6. To serve as a platform for communication on safety and health matters.

Implementation

Within 15 days of getting recommendations of SC, the owner, agent or manager shall inform the secretary about actions taken.

Q. 5. Write statutory provisions on–
Functions of Safety Committee. (2004)

Note : See Q.4. above.

Q. 6. Describe briefly how safety committee can be made more effective.

Increasing the effectiveness of safety committee

(a) Recommendations of 9th National Safety Conference (2000) :

1. In large mines sectional/departmental safety committees may be constituted, under the main safety committees, for specific areas of operation.
2. Tenure of SC should normally be 2 years.
3. Arrangements should be made to train the trainers of SC members.
4. 'Safety Performance Appraisal' should be an agenda item in all meetings of the Board of mining company.
5. SC members should be given orientation training on different aspects of mining and on communication skills – also refresher training periodically.
6. Once a year, mine SC meeting should be attended by senior officials of the Area and Trade Unions to review recommendations and status of implementation. Similar meetings should be held for Area level.

(b) Other suggestions

1. Only active persons with interest in safety should be chosen as SC members. Once a year, the member making most constructive suggestions should be awarded.
2. Meeting should be held on a fixed date every month.
3. For a few hours before meeting, SC members should visit the mine in groups. Dangers/unsafe acts observed should be discussed in the meeting.
4. When special subject is to be discussed, persons of that category should be called by special invitation.
5. The secretary should fix an agenda for the meeting. It should include discussion on accident/incident which might have occurred in the mine, and a review of actions taken on recommendations of previous meeting. Minutes of discussion should be recorded in a register.

6. Manager must attend the meeting punctually and without disturbance.
7. Meeting should not be dominated by manager to give lecture on safety. Members should be encouraged to participate in discussion actively.
8. Surveyor, medical officer & welfare officer should be included in every meeting.
9. Management should implement recommendations promptly & sincerely.

Q. 7. Write a short note on :
Notified disease. (2008)

Notified disease

1. The Central Govt. has, by notification in the Gazette, declared certain diseases as 'diseases connected with mining operations'. These are called Notified Diseases.
2. There are three such diseases of coal mines:
   a. Coal Worker's Pneumoconiosis
   b. Silicosis
   c. Noise induced hearing loss (Added in Feb. 2011)
3. These diseases are caused by inhalation of air containing fine coal dust or silica dust particles, and high noise level.
4. For preventing these diseases, steps are taken to minimise production of dust and for suppressing airborne dust by sprinkling water and removing from the mine by good ventilation. Noise is reduced by better machine maintenance, barricading, isolation etc. (see p. 354)
5. On getting information about a mine employee contacting notified disease, the owner, agent or manager are required to notify within 3 days the Chief Inspector, Regional Inspector, Inspector of Mines (Medical), District Magistrate, and Coal Mines Labour Welfare Commissioner.
6. PME of mine employees helps in detecting such disease in early stages.

Q. 8. Write statutory provisions for : (2009)
Notice of disease.

Notice of disease

If any person employed in a mine contacts any disease notified by Central Govt. in the Gazette, the owner, agent or manager shall, within 3 days of getting information of the disease, give notice thereof (in Form V) to

Chief Inspector

Regional Inspector

Inspector of Mines (Medical)

Coal Mines Labour Welfare Commissioner.

Q. 9. What do you understand by Occupational Diseases? What are the occupational diseases connected with coal mining in India? What are their causes, symptoms and preventive measures? (2006)

Occupational diseases

Due to special circumstances/conditions in some occupations, persons working are likely to suffer from certain diseases. These are known as occupational diseases.

Occupational diseases of coal mines

a. Coal Worker's Pneumoconiosis

b. Silicosis

c. Noise induced hearing loss (Added in Feb. 2011)

	CWP	Silicosis
Cause	Exposure to airborne coal dust for a prolonged period (10-15 years)	Exposure to airborne silica dust for a prolonged period (10-15 years)
Symptoms	*In initial stage* : **No symptoms** *In advanced stage* : **Some panting for breath**	*In initial stage* : ▪ **Difficulty in breathing while working** ▪ **Fever** ▪ **Bluishness of lips and ears** *In advanced stage* : ▪ **Much difficulty in breathing** ▪ **Loss of appetite, pain in chest** ▪ **In the end, death**
Preventive measures	▪ Reducing formation of dust during drilling, blasting & transport ▪ Suppression of airborne dust by water spraying ▪ Regular washing of roof, floor and sides within 50m of the face by water ▪ Use of dust extractors where water cannot be used ▪ Adequate ventilation to dilute and carry away the airborne dust out of the mine ▪ Regular dust survey of workings ▪ IME & PME of workers (including X-ray) ▪ Changing the workplace of persons suffering from the disease ▪ Use of dust respirators by workers where exposure to dust is excessive inspite of all other measures.	

Q. 10. Write statutory provisions for :
Hours of work in a mine below ground. (2009)

Hours of work in a mine below ground

1. No person shall be engaged in a mine below ground for more than 48 hours in a week or more than 8 hours in a day. Work shall be done in shifts not extending to more than 8 hours.
2. If for any reason, a person is engaged for more than 48 hours in a week or 8 hours in a day, he shall be paid wages at double the normal rate of wages for the overtime.
3. No person shall be engaged on any day for more than 10 hours, including overtime, except in case of :
   - Serious danger to safety of the mine or persons employed therein.
   - An accident—actual or apprehended.
   - Any urgent work of attending to breakdown of machinery.
   - Works necessarily to be kept continued.
   - Any act of God.

Q. 11 Write statutory provisions on :
a. Register of persons employed in the mine.(2004)
b. Daily attendance register.

Register of persons employed in the mine (Form 'B')

Particulars of all persons employed in the mine shall be kept recorded in a register (in Form B). No person shall be engaged in the mine unless his particulars have been recorded in this register. The register shall contain one separate page for each person employed, showing:

- Form B serial number
- Name of the employee, name of father/husband
- Age, sex, home address
- Identification mark on the body; token number
- Designation, nature of work (u.g, O/C or surface)
- Date of first appointment in mining industry
- Date of first employment with the present owner
- Date of leaving the mine or removal from the mine
- Vocational Training certificate number
- Name, address and relation of the person to be informed in case of an accident
- Passport size photo
- Signature of the person
- Signature of manager of the mine

Daily attendance register

1. For persons working in the mine, daily attendance registers shall be maintained in Form C, Form D and Form E– **Form C** for persons working below ground, **Form D** for persons working in opencast and **Form E** for persons working on surface.
2. Entry in Form C shall be made at entrance to the mine against name of the person every time he enters the mine or leaves the mine (noting the time).
3. Entries in Form D & E shall be made at beginning and end of working period at suitable places in the premises with reasonable dispatch.
4. No person shall be engaged on work at any time other than that shown in the register.
5. At end of the shift, Attendance Register Keeper shall check whether all persons have come out of the mine or not. In case any person has not come out, he shall inform the competent person.

Q. 12. What is the purpose of periodic medical examination? State briefly the statutory provisions about Periodic Medical Examination.

Periodic Medical Examination

Purpose

A person working in the mine is subjected to difficult working environment in the mine. It may be dusty, hot and humid, noisy, deficient in oxygen, deficient in light and may involve arduous long travel and work in inadequate space. Continuous employment under such conditions may affect his health. Some of the diseases contacted have no treatment till now, just as pneumoconiosis. If he is examined periodically, the discase can be detected in early stage and it can be cured or controlled by proper treatment or change of employment. In extreme cases, he may be given compensation and allowed to leave the employment to save his life. Hence the need for periodic medical examination (PME).

Provisions on PME

1. The owner, agent or manager of every mine is required to make arrangements for PME of all persons employed in the mine, free of charge, at intervals of not more than 5 years.
2. If the examining doctor thinks it necessary, the examination may be done at shorter intervals.
3. At PME centre, management is to make arrangement for x-ray machine, lung function test machine, audiometry etc., and provision of medical officers specially trained is treatment of occupational health diseases.
4. The standard of medical examination has been laid down in the Rules. Medical Officer is required to maintain record of every employee.
5. If as a result of examination, an employee is found unfit for his kind of job, the doctor may recommend a change of work and management may arrange the change. A person found totally unfit shall be paid compensation.
6. If the employee fails to undergo the examination even after being given a repeated notice, his service may be terminated.
7. A person declared unfit may approach the Appellate Medical Board for re-examination.

Q. 13 Write statutory provisions on :
Initial and periodical medical examination. (2006)

Initial and periodical medical examination (IME & PME)

In order to detect in the initial stage itself any person contacting an occupational disease and to ensure timely treatment to prevent aggravation of the disease, Mines Rules provide as follows :

1. Manager, agent or owner of the mine shall arrange for IME & PME of mine employees.
2. Every person appointed in the mine shall be subjected to IME except in case he has undergone such examination in any other mine in the previous 5 years.
3. PME of the following categories of persons shall be done at intervals of 5 years, but, it shall be done at shorter intervals to confirm onset of disease in a person in case of doubt:
   a. Persons employed below ground
   b. Persons deployed for operating dragline, shovel, dozer, scraper, dumper and drill
   c. Persons working on surface as operators of winding engine, locomotive, compressor or any other machine
   d. Persons working in crushing/screening plants.
4. In PME, arrangement shall be made for X-ray, lung function test and audiometry. The X-ray radiographs shall be classified according to ILO Classification to detect stage of Pneumoconiosis.
5. PME center shall be equipped with properly trained doctors.
6. Records of all examinations shall be maintained systematically.
7. Examination shall be conducted as per the standards prescribed in Mines Rules.
8. **Recommendations of 10th Safety Conference (2007)**
   a. IME & PME should be done for every person—whether permanent, temporary or contractual.
   b. PME should be done 3 yearly for mining employees of age over 45 years.
   c. Eye testing of HEMM operators should be done once every year for mining employees of age over 45 years.
   d. Medical examination should include additional tests suggested by the conference.
   e. PME should be done every year for persons over 65 years engaged in workings belowground. (Cir. Tech. 3/2012)

Q. 14. State the statutory provisions regarding employment of women in mines.

Employment of women in mines

1. No woman shall be employed in mine belowground.
2. No woman shall be employed from 7 PM to 6AM.

   However, women may be employed upto 10pm and from 5AM if such notification is given by the Central Government in the gazette.
3. An interval of at least 11 hours shall be given between the finish of work on any day and start of work the next day.

Q. 15. Write a short note on : Shelters in opencast workings. (2001)

Rest shelters in opencast mine (Rule 62 & 63 of Mines Rules)

1. In every opencast mine employing more than 50 persons, adequate and suitable rest shelters shall be provided for employees to take food and rest. The shelters shall be provided at or near loading wharves, in opencast workings and in workshop.

   A canteen shall be counted as a rest shelter.
2. **Standard of shelters :** Every shelter shall–

   (a) have a floor area of not less than 14 m^2

   in case of flat roof – height shall be not less than 2.5m

   in case of sloped roof – a height not less than 1.8m at the lowest part of roof, and not more than 2.5m at the highest part.

   (b) afford effective protection from weather,

   (c) be constantly provided with adequate supply of cool and wholesome drinking water during the working hours of the mine,

   (d) be kept in clean and tidy condition.

Q. 16. State briefly the rules regarding annual leave with wages.

Provisions of annual leave with wages

1. Every person who has completed one calendar year's service (Jan-Dec), is entitled for annual leave with wages (also known as Earned Leave or EL) at the rate given below provided he has put in the minimum attendance :

   Belowground persons : 1 day leave for every 15 days of work (Minimum attendance 190 days)

   Other persons : 1 day leave for every 20 days of work (Minimum attendance 240 days)

In counting the minimum attendance, the following shall be counted as days of attendance :

- the days of layoff,
- the days of earned leave due to work in the previous year, and
- in case of female workers, the days of maternity leave upto 12 weeks.

2. For a person who has joined not on 1st January, the leave shall be calculated on basis of days of actual work, and the minimum attendance required for entitlement shall be as follows :

   For u.g. persons : He shall be entitled for leave if he has put in attendance atleast half of the total number of working days remaining in the calendar year.

   For others : He shall be entitled for leave if he has put in attendance of atleast 2/3rd of the remaining working days of the calendar year.

3. For availing leave, the person has to apply atleast 15 days in advance.
4. If management cannot grant the leave, the leave may be accumulated without limit.

   In normal cases maximum accumulation may be 30days.
5. Annual leave may be taken in 3 instalments in a year.

Q. 17. What are the statutory provisions for supply of drinking water in mines?

Supply of drinking water

1. Management shall arrange to make cool and wholesome drinking water readily available at conveniently accessible points.
2. The quantity shall be atleast 2 litres per person for every person employed at any one time. (If wet bulb temp u.g. is more than 30°C, this shall be 3 litres per person–DGMS Cir. Welfare 1/1978).
3. On surface or in o/c workings if 100 or more persons are employed, the Inspector may order for supply of water effectively cooled by mechanical means.
4. Water shall be supplied free of charge.
5. Supply may be made from taps from the public water supply system, or it may be kept in vessels, sheltered from weather. The vessels shall be cleaned and refilled every day, and kept in clean and hygienic condition.
6. The water shall be from public water supply system. If not, a certificate shall be taken from competent health authority regarding fitness of water for drinking.
7. A good method for u.g. is to give 2-3 litre water bottles to all workers and arrange for cool drinking water at the mine mouth. (DGMS Cir. 12/1956).

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SECTION – B

Question Papers of
OVERMAN'S COMPETENCY CERTIFICATE EXAMINATION

(Conducted by DGMS)

2001 to 2014

Answers to most of the questions are given in Section A

3. During inspection you have noticed that smoke is coming from an intake drift to your district. What action would you take?
4. While driving a development gallery in coal, excessive water percolation is noticed from the roof as well as the face. What are the possible dangers? What precautions need to be taken as per statute?
5. Injuries from fall of roof have increased in your district recently.

   Write a report to the manager of the mine giving possible causes and suggested remedies.
6. Write short notes on the following :
   (a) Systematic Support Rules
   (b) Workmen's Inspector
   (c) Shelters in opencast workings
   (d) Delay detonators

2002

22.12.2002] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. State the statutory provisions for the following :
   (a) Inspection by mining sirdar
   (b) Duties and responsibilities of a shotfirer
   (c) Types of plans which are required to be kept and maintained
   (d) Fencings and gates.
   (e) Taking shelter
   (f) Misfire.
2. What are the causes of mine accidents due to blasting?

   Describe the precautions to be taken to prevent such accidents.
3. Explain different types of steel supports used in development and depillaring districts.

   As an overman of a development district, how will you ensure effectiveness of roof bolts installed?

4. Write short notes on the following :
   (a) Explosion proof stopping
   (b) Graham's Ratio
   (c) Coward's Diagram
   (d) Carbon monoxide poisoning.
5. What is meant by Systematic Support Rules? State the statutory provisions for the same.

   Giving neat sketches, describe the method of roof support in a development district based on roof bolting.
6. How will you show the following on your handplan as per the statute (indicate the colour where applicable)
   (a) Staple pit
   (b) brattice
   (c) door
   (d) goaf
   (e) subsidence
   (f) explosion-proof stopping
   (g) regulator
   (h) telephone
   (i) air-crossing
   (j) underground coal barrier

2003

21.12.2003] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Write the statutory provisions on any two of the following :
   (a) Use, supply and maintenance of self rescuers
   (b) Travelling Roadways
   (c) First aid station
2. What are the causes of accidents due to blasting in opencast mines?

What precautions will be taken to reduce fly rock and ground vibrations due to blasting?

3. Write short notes on any three :
   - (a) Incubation period
   - (b) Systematic Support Rules
   - (c) Explosion-proof stopping
   - (d) Roof bolts
4. What are the statutory provisions regarding standard of ventilation in an underground mine?
5. Write short notes on any three of the following :
   - (a) Carbon monoxide poisoning
   - (b) Self Rescuer
   - (c) Delay detonator
   - (d) First aid station
6. As an overman of a depillaring (by caving) panel, what precautions will you take to guard against the dangers due to sudden fall of overhanging goaf?

2004

18.12.2004] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. As an overman incharge of a district of an underground coal mine, what will you do in the following circumstances and why?
   - (a) The main mechanical ventilator stops for more than 30 minutes.
   - (b) On getting 3% methane in a borehole.
   - (c) Flame safety lamp extinguishes suddenly in underground workings.
2. (i) What is roof bolt?
   - (ii) How does the roof bolt support the roof strata?

   - (iii) What do you understand by anchorage testing?
   - (iv) What is the role of bearing plate in a roof bolt?
3. Write a short note on any three of the following :
   - (a) Auxiliary fan
   - (b) Shotfirer's tools
   - (c) Stone dust barrier
   - (d) Fencings and gates
4. How will you show the following on mine plans (make a sketch showing the colour) :
   - (a) Abandoned incline
   - (b) Underground coal barrier
   - (c) Ventilation door
   - (d) Auxiliary fan
   - (e) Explosion-proof stopping
   - (f) Section of the seam
5. Describe briefly any three of the following :
   - (a) Working by panel system
   - (b) Slope stability in opencast mines
   - (c) Site mixed slurry/emulsion explosive
   - (d) VEQ
6. Write the statutory provisions on any three of the following :
   - (a) Action on report of a Workmen's Inspector
   - (b) Registers for persons employed in mine
   - (c) First aid Room
   - (d) Function of Safety Committee.

2005

17.12.2004] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. How is the roof of an underground coal mine supported by

roof bolts? What is the role of bearing plate in the roof bolt? What is W-strap? How does it help in roof support?

2. What is meant by standing orders? Write the model standing orders for Fire in an underground mine.
3. During inspection of an underground district, you find 50ppm carbon monoxide in the general body of air.

   What steps will you take? What are the possible causes of such incident? What is 'Emergency plan'?
4. What is 'Water Danger plan'? What are the essential features to be shown in a Water Danger plan?
5. What are the statutory provisions regarding Haulage Roadways in an underground mine?
6. Write short notes on any **three** of the following :
   (a) Barometric pressure and its effect on sampling of mine air.
   (b) Rescue tracing
   (c) Intrinsically safe apparatus
   (d) Chemical (oxygen) type self-rescuers.

2006

16.12.2006] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. What are the dangers associated with the following and what precautions will be taken:
   (a) When a seam is being developed over a caved lower seam.
   (b) When a seam is being depillared below an overlying caved seam.
   (c) When a seam is being extracted below surface features.
2. What are the duties and responsibilities of the following competent persons (Answer any three):
   (a) Welfare officer
   (b) Dust incharge

   (c) Lamp room incharge
   (d) Attendant of main mechanical ventilator.

3. A seam 20m thick is outcropping within 50m of a densely populated area. Suggest suitable methods for extraction of the seam near the outcrop. Describe a suitable method giving machinery and manpower, for producing 1.5 lakh tonnes coal per year.
4. What do you understand by occupational diseases? What occupational diseases are associated with coal mining in India? What are their causes, main symptoms and preventive measures?
5. Write short notes on any three of the following:
   (a) Flame proof apparatus
   (b) Initial & periodical medical examinations
   (c) Fresh air base
   (d) Fire in diesel operated HEMM.
6. A decision has been taken to drive a stone drift to cross a 20m upthrow fault. Give a layout with ventilation system, blasting, support, machinery and manpower for achieving a daily progress of 0.5m.

2007

15.12.2007] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Write statutory provisions for:
   (a) Use, supply & maintenance of self rescuers.
   (b) Working & examination of machinery.
   (c) Place of accident not to be disturbed.
2. What are the reasons for air blast? What precautions will be taken to prevent accidents due to air blast? In capacity of shift incharge write a report of accident due to air blast.
3. What are the dangers associated with formation and

propagation of coal dust? What measures will be taken for controlling formation and propagation of coal dust in mechanised faces?

[illegible] fly mention the reasons for the following:

[illegible] pillaring panel being worked by caving, pillars [illegible] d from dip/inbye side to rise/outbye side [illegible] following diagonal/step diagonal line of [illegible]

[illegible] l being worked with stowing, at [illegible] of un-stowed voids (including [illegible] ery) formed by taking slice/stook [illegible] the panel.

[illegible] ction by caving as far as possible, [illegible] upper and lower seams/sections [illegible] cally consequent. Under any [illegible] e line of extraction in lower seam/ [illegible] not be kept advanced beyond the line of [illegible] ction in upper seam/section.

5. What precautions will you suggest for the following (Answer any two):
   (a) During blasting in an opencast mine with active fire.
   (b) While advancing towards water logged workings.
   (c) While re-opening sealed off area.
6. A decision has been taken to drive a drift to cross a 15m thick dyke in a degree II gassy seam. What would be the possible dangers associated with this work? Draw a layout giving ventilation system, blasting, support and machinery deployed.

2008

13.12.2008] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Write short notes on any three of the following :
   (a) Flame proof apparatus

   (b) Intrinsically safe circuit
   (c) Self contained self rescuer
   (d) Interlocking of auxiliary fans.
2. Write statutory provisions for the following :
   (a) Duties of lamp room incharge
   (b) Standard of ventilation
   (c) Duties of workmen's inspector.
3. What steps will be taken by an overman under the following circumstances :
   (a) On getting inflammable gas while drilling in a working face.
   (b) On flame safety lamp getting extinguished during inspection of old workings.
   (c) On abnormal seepage of water in a level face of a development district.
4. Describe a method of extracting coal by depillaring below a seasonal *nalla*. Assume your own conditions.
5. Write short notes on any three of the following :
   (a) Notified disease
   (b) Continuous miner
   (c) Highwall mining
   (d) Fire extinguisher.
6. Write statutory provisions for the following:
   (a) Danger from underground inundation
   (b) Notice of opening
   (c) Notice of accident.

2009

12.12.2009] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. What are the essential elements of effective roof bolting system in an underground coal mine?

propagation of coal dust? What measures will be taken for controlling formation and propagation of coal dust in mechanised faces?

4. Briefly mention the reasons for the following:
   (a) In a depillaring panel being worked by caving, pillars are extracted from dip/inbye side to rise/outbye side systematically following diagonal/step diagonal line of extraction.
   (b) In a depillaring panel being worked with stowing, at any time the number of un-stowed voids (including original and split gallery) formed by taking slice/stook should not exceed 2 in the panel.
   (c) In simultaneous extraction by caving as far as possible, extraction lines in upper and lower seams/sections should be vertically consequent. Under any circumstances the line of extraction in lower seam/section shall not be kept advanced beyond the line of extraction in upper seam/section.
5. What precautions will you suggest for the following (Answer any two):
   (a) During blasting in an opencast mine with active fire.
   (b) While advancing towards water logged workings.
   (c) While re-opening sealed off area.
6. A decision has been taken to drive a drift to cross a 15m thick dyke in a degree II gassy seam. What would be the possible dangers associated with this work? Draw a layout giving ventilation system, blasting, support and machinery deployed.

2008

13.12.2008] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Write short notes on any three of the following :
   (a) Flame proof apparatus
   (b) Intrinsically safe circuit
   (c) Self contained self rescuer
   (d) Interlocking of auxiliary fans.
2. Write statutory provisions for the following :
   (a) Duties of lamp room incharge
   (b) Standard of ventilation
   (c) Duties of workmen's inspector.
3. What steps will be taken by an overman under the following circumstances :
   (a) On getting inflammable gas while drilling in a working face.
   (b) On flame safety lamp getting extinguished during inspection of old workings.
   (c) On abnormal seepage of water in a level face of a development district.
4. Describe a method of extracting coal by depillaring below a seasonal *nalla*. Assume your own conditions.
5. Write short notes on any three of the following :
   (a) Notified disease
   (b) Continuous miner
   (c) Highwall mining
   (d) Fire extinguisher.
6. Write statutory provisions for the following:
   (a) Danger from underground inundation
   (b) Notice of opening
   (c) Notice of accident.

2009

12.12.2009] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. What are the essential elements of effective roof bolting system in an underground coal mine?

2. What precautions will be taken before undertaking the following jobs :
   - (a) Re-opening a sealed off fire area
   - (b) Driving gallery towards possible water logged abandoned workings
   - (c) Abandoning a mine
   - (d) Making overburden dump in an opencast mine worked by draglines.
3. What are the causes of spontaneous heating in underground coal mines? How it can be prevented in a large developing and depillaring mine? Suggest measures for early detection of spontaneous heating.
4. Write short notes on any three of the following:
   - (a) Continuous miner and its safety features
   - (b) Precautions to be taken while extracting by opencast method, developed underground pillars
   - (c) Safety precautions of a large dumper, types of brakes and periodical checking of brakes.
   - (d) Sleeping holes.
5. What are the statutory provisions for the following (Answer any three) :
   - (a) Hours of work below ground
   - (b) Notice of disease
   - (c) Danger from surface water
   - (d) Emergency plan.
6. Under the present scenario of underground coal mines, describe the importance and requirement of man-riding system. Describe briefly safety precautions of such a system.

2010

11.12.2010] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Two persons were fatally injured by a dumper on an overburden bench. Write an inquiry report giving circumstances, cause and preventive measures. Assume your own conditions.

2. Write short notes on any three of the following:
   - (a) Workmen's inspector
   - (b) Dragline
   - (c) Continuous miner
   - (d) Surface miner
3. Write statutory provisions for the following :
   - (a) Duties of manager in emergency
   - (b) Duties of shotfirer at end of the shift
   - (c) Duties of supports man
4. State briefly what is 'accident analysis' and how it helps in reducing accidents.
5. What precautions will you take for the following :
   - (1) Advancing the workings towards water logged mine
   - (2) On getting inflammable gas in a development gallery
   - (3) To prevent spontaneous heating
6. Define the following :
   - (a) Auxiliary fan
   - (b) Competent person
   - (c) Reportable injury

2011

17.12.2011] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Write short notes on any three of the following:
   - (a) Fresh air base
   - (b) Safety Committee
   - (c) Flame proof apparatus
   - (d) Standard of ventilation

2. Define the following:
   - (a) Booster fan
   - (b) Competent person
   - (c) Week
   - (d) Misfire
3. Write statutory provisions of the following:
   - (a) Duties of Sirdar
   - (b) Duties of attendant of main mechanical ventilator
   - (c) Duties of haulage attendant
4. A fatal accident took place due to blown out shots in a development district killing one person. Write an enquiry report stating causes and circumstances leading to the accident and suggest remedial measures to prevent the same. Assume your own conditions.
5. What precautions will you take:
   - (a) While approaching water logged workings?
   - (b) While developing galleries in disturbed and crushed zone?
   - (c) While carrying out blasting for induced caving?
6. A 4 m thick coal seam dipping at 1 in 2.5 is proposed to be developed by semi mechanised method. Roof and floor contain hard sand stone. Describe method of work giving machinery proposed, manpower required including supervision etc. Other conditions can be assumed.

2012

15.12.2012] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Giving a brief description, explain (any two of the following) why :
   - (a) In a depillaring by caving district, pillar extraction is commenced from the dip most/inbye end and continued systematically towards the rise/outbye end maintaining diagonal or step diagonal line of extraction ?
   - (b) In a depillaring with stowing district, not more than two voids are kept unstowed in the panel at any time ?
   - (c) Lines of extraction in two upper & lower seams/ sections are kept coincident as far as possible ?

2. In a development district one person has been fatally injured by blown through shots. Write an enquiry report giving the circumstances and causes of the accident, and suggesting measures to prevent them. Assume your own conditions.
3. Describe causes of failure of roof bolts. How can bolt failures be prevented, give your suggestions stepwise.
4. What precautions should be taken for the following:
   - (a) During blasting in extraction of developed pillars by opencast method
   - (b) While advancing towards old abandoned water logged workings
   - (c) During blasting for induced caving
5. Write statutory provisions for the following:
   - (i) Duties of overman
   - (ii) Notice of accident
   - (iii) Standard of ventilation
6. Write short notes on any three of the following:
   - (a) Surface miner
   - (b) Intrinsically safe apparatus
   - (c) Notified diseases
   - (d) Sleeping holes

2013

14.12.2013] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. All questions carry equal marks.

1. Write short notes on any three of the following:
   (a) Self contained self rescuer
   (b) Safety features of dumpers and testing of brakes
   (c) Workmen's Inspector
   (d) Fresh air base
2. Write statutory provisions for the following:
   (a) Safety Committee
   (b) Place of accident not to be disturbed
   (c) Hours of work in belowground workings
3. What are the causes of spontaneous heating in workings belowground ? Throw light on measures for its prevention and early detection in a large depillaring area.
4. What precautions will be taken for the following:
   (a) While reopening a sealed off area
   (b) For preventing spontaneous heating
   (c) While driving gallery in broken/disturbed and crushed zone
5. What are the causes of air blast? What precautions should be taken for preventing accident due to air blast ?
6. A spotter has been killed during reversal of a dumper in dump yard. Write an enquiry report of the accident giving circumstances and causes leading to the accident and measures for their prevention. Assume your own conditions.

2014

20.12.2014] [Time : 2 Hours

Full Marks 50

Answer any 4 questions. Question no. 1 carries 14 marks, all others carry equal marks.

1. (a) What precautions will you take while advancing belowground workings towards a water-logged body?
   (b) In belowground workings two galleries are approaching each other. What precautions will you take as overman incharge of the section?

2. What is standard of ventilation? What precautions are required to be taken during development in gassy mines? What action will you take on detecting inflammable gas in a development gallery?
3. What precautions will you take in the following circumstances:
   (a) During supervision of loading and transport of over burden by an excavator and 3 tippers/dumpers
   (b) During blasting for induced caving
   (c) On detecting CO on outbye side of an isolation stopping during inspection and examination of isolation stoppings of a sealed off caving panel
4. (a) What precautions will be taken in extraction of developed pillars by opencast method?
   (b) What are the causes of fires in opencast mines?
   (c) What are the dangers associated with blasting in hot strata ? Suggest precautionary measures for the same.
5. Describe importance of the following:
   (a) Diagonal line of extraction in a depillaring panel
   (b) Rock Mass Rating of roof rocks in preparing systematic support rules
   (c) Measurement of roof convergence in a caving panel
6. Write short notes on any three of the following :
   (a) Haulage and travelling roadways in a belowground mine
   (b) Timber supports and anchorage testing of roof bolts
   (c) Burnside boring equipment
   (d) Utility of water dam and its essential fittings

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SECTION – C

BYE-LAWS & NEW SYLLABUS

Overman's Competency Certificate Examination

(Effective from 20th August 2009)

BYE-LAWS & NEW SYLLABUS

Overman's Competency Certificate Examination

BYELAWS FOR CONDUCT OF EXAMINATION, AND GRANT OF OVERMAN'S CERTIFICATE OF COMPETENCY

1. **Application to be supported by documents–**No application shall be considered unless it is supported by **original certificates as to qualifications i.e.**
   - Sirdar's Certificate
   - Gas Testing Certificate
   - Valid First Aid Certificate
   - Degree or Diploma in mining approved by the Board in this behalf
   - Certificates as to

     Literacy

     Sound health

     Character, and
   - Evidence showing that the prescribed fee has been paid.

Amendment to Reg. 15 (2). No person shall be admitted as a candidate to any examination for Manager's, Surveyor's, Overman's or Sirdar's Certificate unless he has passed the [Senior Secondary School examination or Intermediate Examination or its equivalent from a recognised Board or university or passed a Diploma in Engineering or Degree in Mining Engineering or other equivalent qualifications approved in that behalf by the Central Govt.] and for an Engine-driver's or Shotfirer's Certificate unless he satisfies the Board that he is literate.

Provided that nothing in this sub-rugulation shall be deemed to debar a person not satisfying the provisions thereof from being admitted at an examination for any of these certificates for three years from coming into force of the Coal Mines (Amendment) Regulation 2001'' (i.e.3 years from 5.11.2001]

1. *Notification No.* G.S.R.550 (E), *dated 6th June*, 1990

G.S.R. 824 (E), dt 5.11.2001

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2. **Holding of examination–**Examination shall be held at such times and such places as may be fixed by the Board and notified to the candidate. The examination fees of a candidate who fails to appear for an examination at the appointed place and time without sufficient cause to the satisfaction of the Chief Inspector shall be forfeited.

3. **Appointment of examiner–** 1. So far as practicable, the examiners appointed by the Board for each examination shall be two managers holding first class manager's certificate and an Inspector of Mines who shall also act as the Local Secretary of the examination.

   2. Except in an emergency, no member of the Board shall act as an examiner.

4. **Subjects and syllabus for examination–**Candidate shall be examined in the following four subjects–

   (a) General Safety and Legislation

   (b) Method of Working

   (c) Ventilation and Precautions with respect to Explosion, Fires and Inundation.

   (d) Elements of Mining Machinery.

   Detailed Syllabus is laid out in Appendix-I.

5. **Type of examination–** (1) The examination will consist of one written paper (of two hours duration) and oral test by two examiners.

   Provided that if a candidate possesses a Degree or Diploma in Mining approved by the Board in this behalf, he shall be exempted from the written test referred to above.

(2) Written paper shall be meant mainly to test the candidate's ability to write reports, to express himself clearly in writing and to answer elementary questions relating to various subjects mentioned in byelaws. Technical and professional knowledge of the candidates shall be tested mainly at the oral test.

(3) Written paper may be answered in English, Hindi, or the language of the district in which examination is held. Oral test also will be conducted in these languages.

(4) Question paper for the written examination shall be set by the examiner concerned in consultation with the Local Secretary.

(5) Oral test for all candidates may be held at a date or dates on or after the written examination of the candidates who are not holders of a degree or diploma in mining engineering approved by the Board. Date and place of the oral test shall be notified to the candidates by the Local Secretary.

6. **Examination marks–** (1) Written paper and oral test by each of the examiners shall each carry maximum of 50 marks making a total of 150 marks.

   (2) If a candidate secures less that 40% marks in the written paper, he shall not be eligible for oral test. In order to pass in the examination a candidate shall have to secure at least 40% marks in oral test with each examiner and at least 50% marks in aggregate of the written and oral test.

7. **Re-examination–A** candidate who has failed in an examination for an overman's certificate cannot be eligible for re-examination for a period of 6 months from the date of examination when he failed.

8. **Identity and Conduct Of Examination**

   (a) While appearing in examination every candidate shall conduct himself as required by the Secretary.

   (b) Rules laid down in Appendix-II shall be applied to the conduct of written examination.

   (c) In oral examination, every candidate shall bring authorisation issued to him by the Secretary and he shall also produce two copies of recent, clear unmounted photographs of passport size duly attested on the back by the manager of the mine where he is employed or Head of Technical Institution where he studied or Gazetted officer to the effect that the candidate is Shri (name of the candidate) and the photograph is of the said candidate.

9. **Declaration of result–** The result of the examination shall be notified in writing to the individual candidate concerned at a later date.

10. **Re-examination of persons whose certificates were cancelled–**Any person whose certificate has been cancelled by the Board under Reg.26(3) of the Coal Mines Regulations, 1957 may appear in the examination, but not before expiry of three years from date of the order of cancellation.

11. **Penalty for misconduct**–(1) Any candidate who submits a false certificate or counterfeits a certificate or makes a false declaration or adopts unfair means during the examination, may be disqualified by the Board and also debarred from appearing at any subsequent examination for a specified period not exceeding three years depending upon the facts of the case.

    (2) If a candidate who has been declared successful in any examination for the grant of a certificate or who has been granted a certificate, is found to have submitted a false certificate or to have counterfeited a certificate or to have made a false declaration, the Board may cancel his result or withdraw the certificate issued to him, as the case may be.

12. For purpose of these byelaws a degree or diploma in mining approved by the Central Government under provisions of Reg.18(1) of the Coal Mines Regulations 1957 shall be considered to be the degree or diploma approved by the Board referred to in these byelaws.

RULES GOVERNING THE CONDUCT OF WRITTEN EXAMINATION[1]

1. No candidate shall be admitted into the examination hall until he has produced authorisation issued by the Secretary.

   Every candidate should also bring with him his Sirdar's certificate for purpose of identification.

2. No candidate arriving more then 30 minutes late shall be permitted to attend the examination; and any such candidate shall not be eligible for any extra compensatory time.
3. Before entering the examination hall, every candidate shall leave all books, notes and papers etc. outside.
4. Every candidate whall be required to sign in a register in which his roll number would be recorded.
5. Name shall not be written on the answer book. Every candidate shall write his roll number at the top of every page of the paper on which he writes the answers to the questions.
6. Paper will be supplied, and no paper other than that so supplied shall be used.
7. Ink will be provided. Candidates shall bring their own pens and pencils, and drawing instruments etc.
8. Calculations and other work by which a result is obtained shall be clearly shown on the left hand side page on immediate connection with answer to the question under reference.
9. Sketches may be made to illustrate answers. When sketches are asked for, it should be understood that free hand sketches with dimensions are all that is necessary; and candidates need not spend time in making finished drawings.
10. Any candidate desiring to consult the examiner or requiring any paper or other material should stand in his seat to draw attention, but should not shout or call out.
11. Any candidate speaking to any other candidate, or consulting any book or notes, or using paper other than that supplied by the Board, or using any other unfair means or acting in a manner considered improper by the examiner shall be

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[1] Appendix I of the Bye-laws

liable to be disqualified. The Board may, in case of such candidate use its discretion as to permitting him to sit for any future examination.

12. No candidate shall leave the examination hall before one hour has passed after the commencement of the examination.
13. When a candidate has completed the answers to the questions, or when time allowed for answering the questions has elapsed, or when a candidate has been disqualified under Rule 11, he must hand over the answer book to the Secretary of the examination and at once leave the examination hall.

NEW SYLLABUS FOR OVERMAN'S EXAMINATION

(*Effective from 20th August 2009*)

(a) General Safety & Legislation

Duties and responsibilities of workmen, competent persons and officials (excluding managers, assistant managers); discipline amongst workers and control of staff.

Provisions of the Coal Mines Regulations, 1957 relating to mine workings; explosives and shotfiring; haulage; ventilation; precautions against danger from fire, dust, gas and water and other provisions and Rules the enforcement of and compliance with which is the responsibility of overman.

Writing of reports required to be made by overman under the regulations.

Dangerous occurrences in mines and dealing with the same; accidents, their causes and prevention; accident reports; not disturbing the place of accident.

Mine rescue; physiological effect of mine gases; rescue equipment and First Aid.

Sanitation and health; miners' diseases, their symptoms and prevention.

(b) Methods of working

Nature of occurrence of coal seams; geological disturbances and their effects on working conditions; dangers and precautionary measures while approaching geologically disturbed areas.

The purpose and utility of boreholes in mines; shaft sinking; safety devices; temporary and permanent supports in sinking and working shafts; examination of shafts and outlets.

Opencast methods of mining; mechanised and manual methods; deep hole drilling and blasting; shovel and dumpers; dragline; bucket wheel excavators; surface miner; benching; maintenance of haul roads; precautions while extracting developed pillars by opencast method and other safety precautions; methods of reclamation; dump management; high wall mining.

General principles of Bord and Pillar and longwall methods; multi-section workings; methods of depillaring under different conditions; mechanised pillar extraction; precautions to be taken while working near/beneath waterlogged areas; roof convergence and convergence measuring devices etc.; stone drifting.

Elements of roof control; Rock Mass Rating (RMR) of roof strata; mechanism of roof bolting; support of roadways; face supports and their types, setting, testing and withdrawal; systematic support rules; packing and stowing; protection of surface structures; working beneath statutorily restricted areas and surface structures.

Safe handling and use of explosives in coal and stone in gassy and non-gassy mines; simultaneous shotfiring; blasting in fire areas in opencast mines; safety precautions. Inspection of workings; inspection and maintenance of haulage and travelling roadways; man riding system and return airways; gates and fences etc. Reading of statutory plans.

(c) Ventilation and Precautions against Explosions

Fires and Inundation

Natural and mechanical ventilation; ventilation of headings and sinking shafts; siting of auxiliary and booster fans; distribution, measurement and control of air in mines; estimation of air quantity requirements; methods of coursing of air; anemometer; hygrometer; maintenance of ventilation appliances.

Pollution of air; irruption/occurrence of gases in mines; properties of gases; detection and measurement of firedamp and noxious gases; sampling of air; determination of environmental conditions; standards of ventilation.

Design and construction of flame and electric safety lamps; their use, examination and maintenance.

Suppression and treatment of coal dust; suitability of stonedusts; sampling and analysis of coal dust.

Elementary knowledge of causes and prevention of firedamp and coal dust explosion; limits of inflammability of fire-damp.

Prevention, detection and control of spontaneous heating/fire; sealing off fire areas; fire stoppings and their examination; precautions against outbreak of surface fires; fire fighting on surface and belowground.

Inspection of old workings.

Sources of danger from surface and underground water; precautions to prevent inundation and irruptions of water; precautionary measures while approaching abandoned and water logged areas; boring machines for exploratory work; water dams; water danger plan.

Recovery of mines after explosions, fires and inundation; precautionary measure during re-opening and dewatering of mines.

(d) Elements of Mining Machinery

Safety aspects and safe use of different kinds of machinery used in underground and opencast mines e.g. blast hole drills; rippers; scrapers; shovels; draglines; dumpers; road graders; dozers; wheel loaders; bucket wheel excavators; spreaders; surface miners; brakes (including service and parking brakes); use of steam and internal combustion engines in mines.

Application of electricity in mines; safety precautions.

Winding equipments; ropes and guides; signalling and decking arrangements; safety devices; examination of winding equipment and shaft fittings.

Haulage and transport; types of haulages; rope haulage and locomotives; self-acting inclines; haulage roads in underground and opencast workings; rails and tracks; their maintenance and inspection; tubs; signalling; safety devices; codes of practices; traffic rules; unsafe practices; derailments.

Different types of pumps; principles and use of siphons; drainage and water lodgements.

Code of practices for transport, installation, use and shifting of underground and opencast machinery.

Belt conveyors and safety appliances

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SECTION - D

Questions And Answers

RECENT RECRUITMENT TESTS
OF
CIL, SAIL, SINGARENI AND OTHER COAL COMPANIES
&
MULTIPLE CHOICE / OBJECTIVE TYPE QUESTIONS

Questions And Answers

RECENT RECRUITMENT TESTS
&
MULTIPLE CHOICE/ OBJECTIVE TYPE QUESTIONS

Note : Answer is given just after the question.

Q. 1. The most commonly used extraction line in caving panel is :

(a) Straight
(b) Diagonal
(c) Step diagonal
(d) Steep diagonal

(b)

Q. 2. Rise of temperature in a sealed off fire area is indicated by :

(a) Rise of temperature of stopping
(b) Rise of temperature of water issuing out of water seal
(c) Rise of temperature of air issuing from sampling pipe
(d) Any of the above

(d)

Q. 3. LHD is :

(a) Track mounted machine
(b) Tyre mounted machine
(c) Crawler mounted machine
(d) Skid mounted machine

(b)

Q. 4. Track rails in a mine are joined by :

(a) Joining plate
(b) Rice plate
(c) Meat plate
(d) Fish plate

(d)

Q. 5. Slicken sides are :

(a) Polished and striated rock surfaces produced by friction between two sides of a faulted rock
(b) Coal pillar sides which are prone to spalling
(c) Slack side of belting of a belt conveyor
(d) Polished and striated black surfaces produced by slow burning of coal

(a)

Q. 6. Workmen's Inspector writes a report in :

(a) Form U
(b) Form P
(c) Form WI
(d) Form I

(a)

Q. 7. What is the length of buffer of a tub?

(a) 10 cm
(b) 15 cm
(c) 20 cm
(d) 25 cm

(a)

Q. 8. Why V formation of goaf is avoided in depillaring?

(a) To avoid concentration of pressure at the V point
(b) To minimise requirement of supports
(c) To get maximum coal
(d) To prevent air blast

(a)

Q. 8. In India longwall method used is:

(a) Advancing longwall
(b) Retreating longwall
(c) Both (a) & (b)

(b)

Q. 9. The main advantage of main & tail haulage is :

(a) No derailment of tubs occurs
(b) Can cater to high output
(c) Is suitable for undulating roadway
(d) Long train of tubs can be attached

(c)

Q. 10. Attachment fitted to axle of the last tub of an ascending set in direct haulage is known as :

(a) Automatic catch
(b) Drag
(c) Buffer
(d) Stop block

(b)

Q. 11. An accident is known as reportable when period of enforced absence of injured person exceeds :

(a) 24 hours
(b) 36 hours
(c) 48 hours
(d) 72 hours

(d)

Q. 12. Two seams are known as contiguous seams when parting between them is A or less. A stands for :

(a) 3 m
(b) 9 m
(c) 12 m
(d) 18 m

(b)

Q. 13. Full form of RMR is :

(a) Rock Mass Recovery
(b) Rock Measurement Rule
(c) Rock Mass Rating
(d) Rock Mean Recovery

(c)

Q. 14. Run away switch is used in connection with :

(a) Gravity haulage
(b) Direct haulage
(c) Main & tail haulage
(d) Endless haulage

(b)

Q. 15. Fill up the blanks :

(a) Detaching hook operates in conjunction with ....(**detaching plate or bell**)

(b) Jazz rails are provided in direct haulage roadway to prevent runaway of tubs in ....direction. (**forward**)

(c) Drag is used in direct haulage roadway to prevent runaway of tubs in................direction. (**backward**)

Q. 16. During inspection of fire stopping, what will you check about water seal?

Shall check whether water is flowing out through the water seal and how hot it is. If water is not flowing out, shall check whether it is blocked. If it is blocked, U bend of the water seal shall be opened, cleaned and refitted, and the reservoir shall be filled with water. In dry season, water level might have gone down – it will be made up by pouring water into it.

Q. 17. How does CO affect human beings?

It reduces oxygen carrying capacity of the blood. It combines with haemoglobin of blood 300 times faster than oxygen, converting it into a fairly stable compound (carboxy haemoglobin). With every breath, more and more haemoglobin becomes unavailable for carrying oxygen. Respiration, blood pressure and pulse rate increase, and symptoms of CO poisoning appear.

Q. 18. What is adit?

Adit is a horizontal or near horizontal drivage from surface of a hill slope to a coal seam. It is a mine entry.

Q. 19. What are the main parts of a belt conveyor?

Main parts of a belt conveyor are :

(a) Belting

(b) Drive unit

(c) Tail end

(d) Delivery jib

(e) Structure (including uprights, channels, idlers, bottom rollers)

(f) Loop take up.

Q. 20. What is the usual gradient for a locomotive haulage?

1 in 100/200, limiting gradient is 1 in 15.

Q. 21. What is the material of belt used in belt conveyor in a coal mine belowground?

PVC.

Q. 22. What is convergence?

It is relative displacement between two points in roof and floor in a vertical plane at a place due to roof sagging or floor heaving. It gives an indication of increasing load of roof.

Q. 23. Name one instrument used for measuring roof convergence?

Convergence indicator.

Q. 24. What is a detonating relay?

Detonating relay (also known as cord relay or ms relay) is used in opencast mine for providing delay between two blast holes or two rows of blast holes connected by detonating cord. It consists of two detonators placed end to end in a plastic casing. Because of this construction, it is bi-directional, i.e. detonating wave can enter from either side. Each end of casing has a hole for tying detonating cord. Delay time is printed on the casing. In India detonating relays are manufactured with 17, 25, 42 ms delays. Surface hook up can be designed in such a manner that holes get initiated from 2 or 3 detonation paths.

Q. 25. Why water spraying is done at a coal face before and after blasting?

Pre-blasting spraying suppresses dust in and around the face. Post-blasting spraying suppresses dust, fumes and smoke generated by blasting.

Q. 26. What is detonating fuse?

Detonating fuse (or detonating cord) is a plastic or PVC coated cord like thing (5 mm dia) with a core of detonating explosive. It has energy of detonator at every point and serves the same purpose as a detonator, i.e. initiating detonator sensitive high explosive. But it has to be initiated by a detonator.

It is used in opencast mines for blasting long holes. By remaining in contact with the whole column of explosive, it ensures proper detonation of the whole length of explosive column. It is used for connecting 2 holes or 2 rows of holes also.

Note: Special type of detonating cord is used for long hole blasting in BG panels.

Q. 27. What is pot holing?

Pot holing is fall of ground upto the surface with roughly parallel sides. It generally takes place in shallow workings (upto about 60 m) over roadway junctions, especially if there is a thick loose overburden. The loose material acts as a dead weight and shears the strata. Pot hole can be an entry of surface water causing inundation or of entry of air into the goaf causing spontaneous heating/fire.

Q. 28. What is the danger of water accumulation near OB dump in opencast mine?

It causes instability of the dump.

Q. 29. In haulage roadway, what does the following signal stand for :

FOUR RAPS

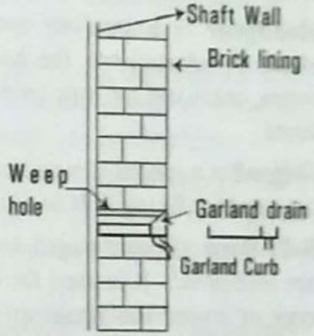
Raise or haul out slowly.

Q. 30. Write full form of : CCM, TPD, OMS, w.g., UDM, LMD, VEQ, FSL, VM, DMS, DGMS, OB.

CCM	Coal Cutting Machine
TPD	Tonnes Per Day
OMS	Output per Man Shift
w.g.	Water Gauge
UDM	Universal Drill Machine
LMD	Local Methane Detector
VEQ	Ventilation Efficiency Quotient
FSL	Flame Safety Lamp
VM	Volatile Matter
DMS	Director of Mines Safety
DGMS	Director General of Mines Safety
OB	Over burden

Q. 31. What is :
Garland Drain
Water Garland
Air Blast
Chain Conveyor
Backhoe
Lag on ignition
Fishplate
Headgear
Dognail
B.P. Book

Garland drain is a drain dug around an opencast mine to prevent entry of outside water in mine.



Water garland is a metallic drain laid around shaft lining to collect water oozing out of the strata.

It generally forms a part of the bricking curb over which shaft lining is built. Curb is made up of sections bolted together. One of these sections has a hole to fit the drain pipe for channelling water to the next lower water garland or to sump. Weep holes are left in brick wall at curb level.

Air blast is the rushing out of a large volume of goaf air at a very high velocity through narrow exits due to sudden fall of a large area of goaf. The strong blast of air blows away stoppings, tubs, supports, men etc. whatever come in its way. Men are killed and workings are filled up with noxious goaf gases and coal dust.

Chain conveyor (or scraper chain conveyor) is a conveyor comprising of one or two endless linked chains with crossbars or flights at intervals to carry coal. Loaded side of conveyor runs in a steel trough while empty side returns along guides underneath. Material is transported on conveyor partly by riding on chain and flights and partly by being scraped along in the troughs. It is used as face transport in coal mines. Capacities range upto 100tph with lengths upto 60m.

Backhoe is a hydraulic shovel, open end of the bucket of which is towards the shovel. It stands on top of the bench and loads material of the bench on which it sits. In a way it is a large mechanised form of a spade.

Lag on ignition is the time interval between exposure of methane-air mixture to an igniting source and the appearance of flame. It falls with rise in temperature of the source of ignition.

For a 6.5% mixture, it is 11 second at 700 ^{0}C but only 0.02 second at 1200 ^{0}C. It is an important property of methane. Flame safety lamp, permitted explosives, approved exploders and FLP enclosures are designed utilising this property.

Fishplate is a steel plate for joining the end of one rail to the next rail in the track. Fishplates are fixed (one on each side) to overlap the rail ends and bolted through the rails.

Headgear is a steel or concrete structure erected over mine shaft. It (a) supports the headgear pulleys, weight of winding ropes, cages and the rope guides, and (b) guides the cage to banking level.

Dognail is a special iron nail in the shape of the nail of dog. Dognails are used for fixing rails to wooden sleepers of the rail track.

B.P. Book (Bound paged book) is a bound book whose pages are numbered. It is used for keeping statutory records. For each type of inspection/examination, a separate B.P. Book is used.

Q. 32. Define : face of underground mine,
banksman,
onsetter,
overriding of pillars.

Face means the moving front of any working place or the inbye end of any gallery, roadway or drift.

Banksman is a person at top of a shaft, who supervises loading or raising/lowering of persons, tools and materials and transmits signals.

Onsetter is a person at the pit bottom or inset landing, who supervises loading and un-loading of cages or skips, lowering and raising of men and transmits signals to pit top.

Overriding of pillars. A strong thick stratum of massive sandstone in the roof immediately above the seam delays roof fall. When a large number of pillars are extracted, main roof ultimately breaks with the build up of pressure. If pillars on outbye side are not strong enough, they may get crushed. This phenomenon is known as overriding of pillars and it results ultimately into *premature collapse* of the area.

Q. 33. Explain why :

Water spraying is done in and around coal face both before and after blasting?

Rib of coal is left against the goaf during pillar extraction?

Goaf edge support is made the strongest?

About 0.6m coal is left against shale roof during development?

Water spraying before blasting suppresses dust, water spraying after blasting suppresses dust, smoke and fumes generated by blasting.

Rib of coal left against the goaf during depillaring prevents falling goaf stones from entering the working area.

Goaf edge support is made particularly strong to break the roof at the goaf edge, otherwise the roof will sag instead of breaking and exert excessive pressure on supports in working area.

Shale has a tendency to absorb moisture from mine atmosphere, and part layer by layer, collapsing without warning. Coal left against the roof prevents all this. This coal left during development is taken during depillaring.

Q. 34. What is : (a) VEQ, (b) Downthrow fault, (c) Manhole?

VEQ (ventilation efficiency quotient) is the ratio of quantity of air (Q_2) reaching the last ventilation connection in the district and the quantity of air (Q_1) entering the district.

$VEQ = Q_2/Q_1 \times 100\%$

VEQ depends on number of stoppings and quality of their construction.

Downthrow fault is a fault which has displaced the strata downwards relative to workings approaching it. The same fault would be called an upthrow fault if it is approached from workings on the opposite side.

Manhole is a narrow recess made in the side of haulage roadway for workmen to take shelter when rope is in motion. Manhole must be not less than 0.75m, not more than 1m wide and not less than 1.8m high. Manholes are made on one side of haulage roadway, and kept whitewashed and free from obstructions.

Q. 35. What is the purpose of water seal in isolation stopping?

Water seal prevents accumulation of water behind isolation stopping. It permits water from sealed area to come out without permitting air to enter the sealed area.

Q. 36. What are lashing chains and where are they used?

Lashing chain is a short chain (about 3m) used to attach tubs to an over-rope endless haulage by wrapping it around the rope. One end of the rope is attached to drawbar hook of the tub and the other end to secure it to the rope at the lashing end. Two lashing chains are used at a time-- one at front and one at rear of the tub.

Q. 37. Fill up the blanks:

(a) Attachment fitted to the axle of last tub in an upcoming set of tubs in direct rope haulage is called ....

(b) CH_4 should not exceed........... in the general body of return air of the district and...........in any other place in the mine.

(c) Shafts, inclines or other outlets to surface should not be less than...........m from one another at any point.

(d) No working should be made and no work of extraction or reduction of pillars should be extended to any point within...........m of any railway or public works, roads or buildings or other permanent structure not belonging to the owner without prior permission of........... .

(e) Automatic contrivance prevents the descending cage landing at pit bottom at speed not exceeding ....

(f) P5 explosive is used for........... .

(a) Drag or backstay

(b) 0.75%, 1.25%

(c) 13.5

(d) 45m, Chief Inspector

(e) 1.5m/s

(f) Solid blasting

Q. 38. What difficulties are likely to be faced while working virgin seam over a caved goaf?

Difficulties while working virgin seam over a caved goaf

- Difficulty in haulage due to changes in gradient. Problem is maximum along edges of caved area and pillars or barriers left in lower seam.

- Difficulty in strata control due to fractures in strata induced by caving.
- Difficulty in ventilation due to cracks connecting with the goaf.
- Danger of water or black damp if rise side goaves in the lower seam contain water or black damp.

Q. 39. What is main and tail haulage?

Main & tail haulage is a single track haulage system operated by a haulage engine with two drums, each with a separate rope. Engine is located usually at outbye end of the system. Main rope is attached to outbye end of the set of tubs, and the tail rope passes round a sheave inbye and is then attached to the rear end of the set.

To draw the full set out, main rope is wound in, tail rope being allowed to run free. To draw the empty set inbye, tail rope is wound in, main rope being allowed to run free. Tail rope is equal to twice the length of haulage rope.

Main and tail haulage is used when the gradient is irregular and the empty set will not run inbye by gravity.

Q. 40. What are : Rope guides
Safety belt
Shuttle car
Keps
Turbine pump

Rope guides are steel ropes suspended in a shaft to prevent excessive swing of the cages. 8 guide ropes are generally used for the shaft, 4 for each cage. Guide ropes are kept taut in the shaft by means of cheese weights in shaft bottom sump.

Safety belt is a protective belt or harness with remote anchorage, worn by workman –for example, a person repairing a shaft or headgear, or a quarry worker working on a face at a height. Since the belt allows a drop of about 1.8m, a shock absorber is provided. Safety belt is inspected periodically and every time before use.

Shuttle car is a low height rubber tyred vehicle designed to take load from continuous miner at the face and to discharge it into district belt conveyor. In the central portion, it has a chain conveyor which advances the load when loading and discharges it when un-loading. Travel speed 5-6kmph, capacity 10-15t.

Keps are steel supports on which the cage rests at the pit top during loading or un-loading so that the rail track is always at proper level.

Turbine pump is a common type of water pump used in mines. It consists of an impeller rotating within a spiral casing which has stationary diffusing channels. As the impeller rotates, water enters at the centre and is thrown at a high speed into the spiral casing due to centrifugal action.Here, kinetic energy is converted into pressure energy. In a multi-stage turbine pump, this water enters into the eye of the next impeller. Each stage can develop a 90m head.

Q. 41. What are sleeping holes? Briefly mention the precautions for sleeping holes.

Sleeping holes. In opencast mine, holes loaded with explosives if not blasted the day they are loaded, are known as sleeping holes. Sleeping of holes cannot be avoided in large opencast mines as very large blasts are conducted involving a large number of holes. Loading of holes takes more than a day. Sometimes loaded holes cannot be blasted the same day as equipment nearby cannot be withdrawn to safe distance due to breakdown. In shovel benches, sleeping can go upto 7 days and in dragline benches upto 15 days as permitted by the Chief Inspector.

Q. 42. What precautions are taken for sleeping holes?

Precautions for sleeping Roles

1. Taking prior standing permission from Chief Inspector.
2. Leaving atleast 2 rows of charged holes between the loaded holes and the hole being drilled.
3. Stemming of holes immediately after loading.
4. Covering detonating cord of the hole with soft stemming material.
5. Making connections only just before blasting.

6. Using only detonating cord in the holes. Attaching detonators to the detonating cord on surface only.
7. Cordoning off the area. Marking the area of loaded holes by bright red flags during the day and fluorescent paint at night.
8. Not permitting smoking and open flames within 60m of the loaded holes.
9. Maintaining a record of holes drilled and loaded date-wise and the date of blasting.

Q. 43. What is highwall mining?

Highwall mining is a method of extracting coal beyond the economic limits of opencast mine by driving a series of parallel rectangular or circular entries 200-300m deep into the exposed seam. Entries are driven by a remotely controlled modified continuous miner under remote guidance. Cut coal is conveyed out by a system of conveyors or augers. The method is widely used in US and Australia, and is now being introduced at several mines in India.

Q. 44. What are the duties of shotfirer at end of his shift?

Duties of shotfirer at end of his shift

1. Returning unused explosives to magazine incharge.
2. Writing a shift report in a B.P. book kept for the purpose, showing :

   Quantity of explosives taken, used and returned

   Number of shots fired place-wise

   Mis-fires, if any.

Q. 45. Write full form of : SMS, SME, ANFO, BWE, NLC, NCL, SCCL, BG panel, NEC, CIMFR.

SMS	Site Mixed Slurry
SME	Site Mixed Emulsion
ANFO	Ammonium Nitrate Fuel Oil mixture
BWE	Bucket Wheel Excavator
NLC	Neyveli Lignite Corporation
NCL	Northern Coalfields Ltd.
SCCL	Singareni Collieries Company Ltd.

BG Panel	Blasting Gallery Panel
NEC	North Eastern Coalfields
CIMFR	Central Institute of Mining & Fuel Research

Q. 46. What is : Safety Hook
Automatic Contrivance
Audio Visual Alarm
Drawbar
Washout
Contour Line
Stone Dusting
ROM Coal
Tippler
Continuous Miner

Safety hook (or detaching hook) is a safety device fitted in cage suspension gear just below the rope cappel. It is used to suspend the cage in headgear, over the detaching plate or bell plate, in the event of an over-wind, and at the same time to release (detach) the rope (along with cappel) to go over the headgear pulley. It is fitted in man-winding shaft.

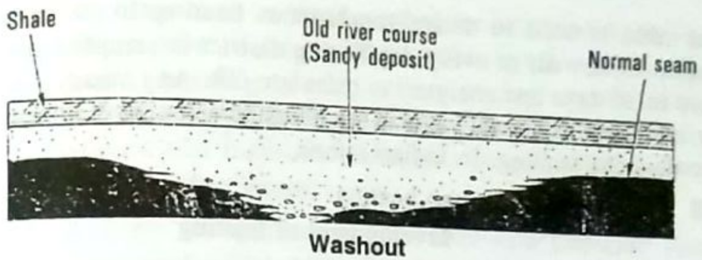
Automatic contrivance is a device fitted on winding engine of man-winding shaft more than 100m deep (as per the regulations, and more than 75m deep as per the joint decision of DGMS and the industry). It prevents over-speeding, over-winding, excessive landing speed of the down-going cage, and the cage running in reverse direction after over-winding due to driver's mistake.

Automatic contrivance remains in full and fixed engagement with winding engine, or it is fully engaged by the winding engine driver before men are allowed to enter the cage. A proper indicator is provided to show the banksman that this has been done.

Audio visual alarm is a safety device fitted on trucks, dumpers or other HEMM to warn persons standing behind the reversing vehicle so that they do not get crushed. As soon as the vehicle is put in reverse gear, a special horn starts blowing and the back light flashes. AVAs used should be of type and make approved by DGMS.

Drawbar is a steel bar which extends from one end to the other along the bottom of a tub or mine car so that it can be coupled to a haulage rope at either end.

Washout is a belt of barren ground or thin coal produced by erosion of the seam by river which flowed during or soon after the deposition of coal. These erosion channels have subsequently been filled with sandy sediments.



Washout

Continuous miner is a large heavy underground mining machine that can cut and load 10-12t of coal per minute. It is used in u.g. coal mines for development as well as for pillar extraction. The machine has a cutter head with a number of drums fitted with cutting picks. Cut coal falls into the conveyor at centre of machine which loads the shuttle car standing behind.

The machine is radio remotely operated. Automatic CH_4 detector mounted on the machine trips power if CH_4 exceeds 0.5%. A large number of water spray nozzles fitted on the machine reduce production of coal dust, suppress air borne dust and ventilate the area around the picks to dilute CH_4 released.

Contour line is a line drawn on a plan or map to represent an imaginary line on the ground of a definite level. Contours give an idea of relief of the surface and the drainage pattern. Surface and u.g. mine plans are marked with surface contour lines at intervals not exceeding 5m.

Stone dusting is the process of systematic distribution of stone dust along roof, floor and sides of mine roadways to cover the coal dust and reduce its inflammability.

ROM coal is short form of Run- Of-Mine coal. It is the raw coal as delivered by tubs or conveyors and prior to screening or treatment of any sort.

Tippler is a steel structure with a rail track which can receive and rotate the coal tub for discharging the contents. It may be side discharge type or end discharge type or rotary.

Q. 47. Define Graham's Ratio. What is its utility?

Graham's Ratio

In an underground coal mine, ratio of CO produced to O_2 consumed, expressed as a percentage, is called Graham's Ratio or Graham's Index.

$GR = CO\ produced/\ O_2\ consumed \times 100\%$

The ratio is used to detect spontaneous heating in its earliest stages. Return air of every depillaring district is sampled atleast once in 30 days and analysed to calculate GR. Any steady rise in the ratio over its normal value in the mine indicates development of spontaneous heating. In Indian mines,

GR	0 to 0.1%	no heating
	0.1 to 1%	development of heating
	2%	active fire

Q. 48. What is Coward's Diagram?

Coward's Diagram is a diagram which shows explosive potential of a methane-air mixture, the effect of change in oxygen percentage and the effect of dilution of the mixture by air. The diagram is used when sealing-off a fire or when re-opening a sealed-off fire area.

Q. 49. What is the purpose of portable fire extinguishers? At which places portable fire extinguishers are kept in a mine?

Portable fire extinguishers are meant to deal with fire in initial stages. If fire is not dealt with promptly, it may soon develop into a major fire or even a disaster.

Portable fire extinguishers are kept at the following places :

- Mine entrance, pit bottom , landing, entrance to every district
- Places where timber, grease or inflammable materials are stored
- Engine room
  Electrical sub-station
  Belt conveyor drive head
  Diesel engine maintenance workshop
  Diesel oil filling station
  Battery charging station
  Lamp room
- On LHD, SDL, continuous miner, shuttle car etc.
- On every HEMM
- Store and workshop on surface

Q. 50. What are the provisions regarding working below surface structures?

Working below surface structure

1. No pillar shall be made and no work of extraction/reduction of pillars shall be conducted at, or extended to any point within 45m of any railway, public works or any public road or building, or other permanent structure not belonging to the owner of the mine without prior written permission of the Chief Inspector and subject to such conditions as he may specify therein.
2. A copy of application for permission shall be sent to concerned public authority also.
3. Stability of surface structure shall not be endangered until it has been dismantled, diverted or vacated.
4. To keep a check on the conditions u.g., regular inspection of u.g. workings shall be made atleast once in every month by competent person and once in 3 months by the manager personally. A record of inspection shall be maintained.
5. To facilitate inspection, each pillar of such workings shall be kept marked on all sides, at a convenient height, by white band in lime wash with width not less than 15cm.
6. As long as the mine workings on outbye side of restricted areas are not depillared, atleast 2 approach roads shall be maintained in good condition.
7. Where stability of any such surface structure is endangered due to mining, Chief Inspector may require the owner to construct protective works specified by him within the time frame given by him.

Q. 51. Write short note on : Rock Mass Rating
Fresh Air Base

Rock Mass Rating (RMR) is a system of designating the nature of immediate roof (upto 2m above the gallery height) in the mine on the basis of 5 parameters :

	Weightage
Layer thickness	30
Structural features	25
Rock weathering property	20
Rock strength	15
Ground water seepage	10
	100

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Rock Mass Rating (RMR) is a system of designating the nature of immediate roof (upto 2m above the gallery height) in the mine on the basis of 5 parameters :

	Weightage
Layer thickness	30
Structural features	25
Rock weathering property	20
Rock strength	15
Ground water seepage	10
	100

If there are different types of rocks in immediate roof, combined RMR is found from individual RMRs and thickness of each type of strata.

RMR so obtained is again adjusted according to depth of workings, method of work, gallery width etc.

Roof is categorised as follows :

RMR	
0-20	very poor
20-40	bad
40-60	fair
60-80	good
80-100	very good

Fresh Air Base (FAB) is a place in fresh air near an area of irrespirable zone u.g. in which rescue/recovery operations are to be conducted. It is the base station from which a rescue team starts its operations.

FAB is connected by telephone to surface, or if it on surface, to the pit bottom.

It is equipped with men and materials as follows:

Men

- 2 men—a qualified doctor and a rescue trained person having knowledge of workings
- A spare rescue team ready with apparatus for immediate services

Equipment

- One or more reviving apparatus, O_2 revivers
- F.Aid box, stretcher
- Means of testing CO, hygrometer, 2 flame safety lamps

Rescue team shall not proceed beyond FAB, unless the FAB is fully equipped with men and materials. If men are already at work beyond the FAB, it shall be fully equipped with men and materials at the earliest.

Q. 52. Define : Contiguous seams
Gassy seam of 2nd degree
Gassy seam of 3rd degree

Contiguous seams

Two seams lying within 9m of each other are known as contiguous seams.

Gassy seam of 2nd degree

A seam is known as gassy seam of 2nd degree if:

- % of inflammable gas in general body of air at any place in the workings u.g. (within the precincts of mine) is more than 0.1%

OR

- Rate of emission of inflammable gas per tonne of coal produced exceeds $1m^3$ but does not exceed $10m^3$.

Gassy seam of 3rd degree

It is a seam or part thereof lying within the precincts of mine (not being an opencast mine) in which rate of emission of inflammable gas per tonne of coal produced exceeds $10m^3$.

Q. 53. Fill up the blanks :

(a) Panel size is fixed keeping in view ______________ and ....
(b) SDL is .... mounted.
(c) Track rail is bent using ____________ .
(d) Run away switch is used in connection with ____________ .
(e) An accident called reportable when period of enforced absence of injured person exceeds ____________ .

(a) incubation period of seam and rate of extraction of coal.
(b) crawler mounted.
(c) jim crow. (Jim Screw)
(d) direct haulage.
(e) 72 hours.

Q. 54. Explain why : 'V' formation of goaves is avoided in depillaring?
Silt is removed regularly from pit bottom sump?
Shale roof is not good?

V formation

V formation of goaf is dangerous, because at that point both the extraction lines meet and there is an excessive pressure which may crush the supports and stooks.

Removal of silt

If silt is not removed regularly from pit bottom sump, accumulated silt will not leave adequate space for cheese weights of guide ropes to move freely. Guide ropes may slacken and cause collision of cages.

Shale roof

Shale roof is not good because :

- Shale has a tendency to absorb moisture from mine atmosphere and become weak.
- Shale has a tendency to part in layers.
- Shale roof falls without warning.

Q. 55. What is : Ripper dozer
pony conveyor
dragline
tandem cage?

Ripper dozer is a dozer fitted with a plough like attachment at the rear portion to 'rip' the ground. In coal mines, a single shank ripper is used which can rip 0.5 to 1m of the ground. Movement of ripper shank is controlled by hydraulic pusher rams. In conjunction with scrapers, it provides a good means of OB/coal removal in areas in close proximity to habitation. It can also be used for ripping and separating thick stone bands of the coal seam.

Pony conveyor is a small light belt conveyor used near coal faces, in preference to chain conveyor. Pony conveyors reduce the 'lead' and improve production and productivity of loading machinery like SDL, LHD.

Dragline is a long boomed crane like machine which lifts the earth, soft rock or blasted OB from the face into its bucket and dumps it straight into the de-coaled area of the quarry. Bucket is lowered into material to be loaded by manipulation of ropes and is dragged by them. As it is dragged, it gets loaded. Hence the name dragline. With the loaded bucket, boom with the machine house swings towards the OB dump where the drag rope overturns the bucket to discharge the load.

Small draglines are crawler mounted, but the bigger ones are walking draglines. A dragline of bucket capacity 24m^3 and a boom 96m long is known as 24/96 dragline. Over 40 draglines are in use in Indian opencast coal mines.

Tandem cage is a cage which can accommodate two coal tubs end-to-end. Some large winding shafts in Indian coal mines are fitted with tandem cages.

Q. 56. Explain what is : (a) Glare,
(b) VOD,
(c) Cast booster,
(d) smoke helmet.

Glare is the sensation produced by a bright source of light which is much brighter than the level to which the eyes are adapted. It causes annoyance, blinding, discomfort and loss of eyes' ability to see. Bright and un-shielded vehicle lights cause glare in eyes of drivers of other vehicles and is a cause of many road accidents of vehicles approaching from opposite directions. Lighting in mines is so designed as to be free from glare.

VOD (Velocity of Detonation) is the velocity at which detonation wave travels through a column of explosives. High explosives have a VOD of 2500-7000m/s. Rocks with low strength need explosives with a low VOD.

Cast booster is a high density explosive unit of a high VOD used to initiate large dia column charge of bulk explosives or ANFO. Generally, it has an inner core of pentolite (50/50 mixture of TNT/PETN). Cast boosters have a VOD of over 7000m/s. In India, cast boosters are manufactured in 100g, 200g and 250g size.

Smoke helmet is a raw hide helmet covering the head and having mica eye pieces. It has about 36m flexible hose for supplying fresh air from a distance to the wearer for work in irrespirable atmosphere. Air is forced into the hose by bellows or a fan worked by a person in fresh air. The exhaled air passes from helmet via the loose joint around the shoulder of wearer.

It is used for :

(i) Fire fighting,
(ii) Rescuing persons from irrespirable air,
(iii) Opening ventilation doors in smoke laden air, and
(iv) Other recovery work within range of the apparatus.

Q. 57. What items are kept in pocket first- aid kit by mining staff?

Pocket first- aid kit

Every mining sirdar and overman is given a first aid pocket kit for first aid of minor injuries in the mine. It is a small dust and water proof packet containing bandages (one small/one big), burn dressings, sterilised cotton, Dettol or other antiseptic.

Q. 58. What is : AFC,
Lal munia

AFC is a heavy duty chain type flexible conveyor capable of being advanced with the longwall face without dismantling. It is designed to carry cutter loader/drum shearer. Cut coal falls into AFC which transports it to the district belt conveyor through stage loader.

Lal munia is a warm blooded bird used in u.g. coal mines in India to get indication of presence of CO. Distress of the bird gives indication of CO.

Q. 59. Which instrument is used for measuring air quantity in a mine?

An anemometer or a velometer is used to measure air quantity in a mine.

Q. 60. Which subsidiary of Coal India has no underground mines?

Northern Coalfields Limited.

Q. 61. Write short note on : Chair lift system
Anchorage testing
Endless rope haulage

Chair lift system is a type of manriding system used in many u.g. coal mines in India. It consists of an endless rope running slowly along roof of travelling roadway and a number of chair lifts (hangers made of steel pipes with chairs) stacked at either end of the journey and at regular alighting/riding stations. A person who wants to travel, picks up the chair lift from the stack, hangs it on the rope and sits on the chair. At the alighting place, he gets down, removes the chair lift from the rope and puts it into the stack nearby. The system has a number of safety devices.

Anchorage testing is a process of testing installed roof bolts chosen at random for checking the grip or anchorage of roof bolt, i.e. efficiency of roof bolting. About 10% of the installed roof bolts are subjected to anchorage testing using properly maintained and calibrated testing machine. Anchorage testing is done under supervision of an under manager.

Endless rope haulage is rope haulage with two tracks -- one for the empty tubs travelling inbye and the other for loaded tubs being hauled outbye simultaneously. The endless steel rope passes round a pulley which is rotated by an engine through a suitable gearing and around a sheave at the inbye end of haulage rope. Tubs are attached singly or in sets at regular intervals. Rope travels continuously in one direction at a speed of about 3kmph.

System is capable of hauling over long distances, but requires wide roadways to accommodate the double track. It is normally used in relatively flat seams.

Endless haulage maybe an over-tub endless haulage or an under-tub endless haulage.

Q. 62. Name the parts of roof bolt and their dimensions.

Parts of roof bolt

Bolt : of MS steel or TMT Rebar (of specified physico-mechanical properties and chemical composition), of circular cross section with ribs on its circumferential region.

Length atleast 1.5m.

Dia. 20-22mm.

Length of thread 150mm.

Bearing plate : a domed washer plate of 150 × 150mm, thickness 8mm (minimum),

with compatible central hole and angled sides to accommodate conical seat and nut.

Minimum load capacity 14t.

Conical seat : of forged steel,
capable of not getting deformed at less than 1.2 times the yield stress of roof bolt.

Nut : hexagonal,
Thickness not less than 30mm.

Capsules : cement capsules or resin capsules of approved type.

Cement capsules of quick setting type, provide minimum anchorage of 3T after 30min and 5T after 2 hours.

Resin capsules provide minimum anchorage of 12T in 30mins and 20T in 24 hours.

Q. 63. What is : TISCOG,
Form 'B' Register,
Stage loader?

TISCOG is a steel cog made of TATA Steel, 7.2mm x 7.2mm square hollow section, in the form of a cube 900 x 900 x 900mm. It is so designed that 2 or more such cubes can be bolted together. After installing at the place of support, wooden sleepers are placed on it in criss-cross manner upto the roof and tightened by hammering wooden wedges. It can take a load of upto 50t. TISCOGS are used in many coal mines.

'B' Form Register is a register maintained at every mine in which particulars of all persons employed in the mine are kept recorded. No person can be engaged in the mine unless his particulars have been noted in this register. The register has one page for each employee in which his photograph is also pasted. It is signed by the employee and the manager of the mine.

Stage loader is about 20m long, heavy duty auxiliary chain conveyor installed in the main gate of the longwall panel. It receives coal from the AFC and loads it on the gate belt conveyor. It stabilises the coal and prevents damage of belt conveyor.

Q. 64. Describe briefly the Blasting Gallery Method.

BG method is a method of depillaring thick coal seams. The method involves drivage of level galleries along floor of a seam and depillaring by drilling holes in a fan-cut pattern around the gallery to full thickness of the seam. Full thickness of the seam is extracted by retreating along the galleries while blasting and loading successive slabs.

Due to use of long holes, the method requires special P-3 explosive and accessories. Explosives charge is distributed in the hole with the help of spacers. Special detonating fuse connects all cartridges of the hole , and the last cartridge is tied with a No. 6 detonator.

Blasted coal is loaded by remote controlled LHD and discharged into chain conveyor which feeds district belt conveyor.

For speedy development, road headers are used.

Gallery height is kept 3m and pillar size 9-11m x 60m. For a 10-11m thick seam, 33 holes are drilled in a ring-cut fashion in such a way that they cover half of the pillar towards the rise and half of the pillar towards the dip from the level gallery. The method is widely used in mines of SCCL for 6-15m thick Deg.I gassy seams of moderate dip (1 in 6 or less). To prevent spontaneous heating, CO_2 or N_2 is pumped into the goaf as extraction proceeds.

Q. 65. Write a short note on : Universal Drilling Machine,
Bucket Wheel Excavator.

Universal Drilling Machine (UDM) is a crawler mounted electro-hydraulic machine which can drill holes in the face for blasting and also holes in roof/side/floor for bolting at various angles. Hence, it has been named UDM.

The machine is powered by a 22kW FLP motor, and can drill 38-63mm dia. holes 3-20m long. Drilling is fast and saves the driller from nuisance of coal dust.

The machine improves production and productivity of loading machines and makes it possible to achieve higher progress per blast than is possible with hand held drills. A large number of UDMs are being used in various mines.

Bucket Wheel Excavator (BWE) is used only in lignite mines for extraction of soft OB or lignite. It has a large rotating wheel, periphery of which has a number of cutting buckets. Buckets get loaded when the wheel rotates and get un-loaded as they rise up in the wheel. Material falls into the boom conveyor of machine which feeds its discharge conveyor for discharging coal onto the belt conveyor system of the mine.

Each OB or coal bench has a separate BWE. Excavated OB goes to OB dump, and the coal to coal bunker. Depending on the size, BWE can dig 2000-4000m^3 of material per hour.

Q. 66. Explain why CO_2 fire extinguishers cannot be used effectively for fires in mine roadways?

In a mine roadway, CO_2 will get diluted by high volume of air flowing in the roadway before it can extinguish the fire.

Q. 67. What precautions should be taken by drill operator using large drilling machine in opencast mine?

Precautions by drill operator

1. Set the machine level and at right angles to the face.
2. Before raising the mast, see that none is present in danger zone and there is no power/telephone line nearby. Lock the mast after raising it.
3. Before marching, ensure that all levelling jack pads and the drill bit are off the ground and the mast lowered.
4. Use dust suppression system.
5. At shift beginning, check all controls and safety devices.
6. At shift end, leave the machine at a safe place.
7. Take care that drill cable is not crushed by the machine, and the cuttings do not fall into the drilled holes during marching of the machine from hole to hole.

Q. 68. What are the duties of mining sirdar in respect of support of workings?

Duties of mining sirdar in respect of support of workings

1. To check roof and sides of working places and roadways under his charge and to arrange necessary dressing/support.
2. To observe SSR strictly.
3. To ensure availability of sylvester machine in good condition.
4. To make sure that no support is withdrawn without using the sylvester.

5. To ensure availability of bunton of adequate length and ladder if height at any place is more than 3m.
6. To get dangerous operations, like clearing off a fall, done in his presence.

Q. 69. What is interlocking of auxiliary fans?

Interlocking of auxiliary fans

If two or more auxiliary fans are installed in a ventilating district, they are electrically interlocked by a sequence control system which ensures that a fan will not start unless the fan on its intake side is running.

If intake side fan is not running, air entering the return side fan is likely to contain a high quantity of dust and methane.

Q. 70. What is fleet angle?

Fleet angle is the angle between the vertical plane of headgear pulley and the rope when cage is at the pit bottom or pit top. Fleet angle should not exceed 1.5^0 otherwise there will be excessive wear of the winding rope and the headgear pulley.

Q. 71. What is OMS?

OMS or output per manshift is a method of expressing productivity of mines, districts, miners.

Q. 72. Write a short note on stone dust barrier?

Stone dust barrier is provided to prevent an explosion extending from one part of the mine to the other. It consists of a number of shelves (boards) loaded with stone dust and erected at strategic points in the mine roadways. In the event of an explosion, pressure wave in advance of the flame front upsets the lightly constructed shelves. Falling dust forms a dense cloud or curtain of inert dust which blankets the flame and arrests further propagation of the explosion.

Stone dust barriers are installed in gassy seams of Deg. II and III, and in development workings of Deg. I seams in which there is likelihood of occurrence of inflammable gas in dangerous quantities.

Q. 73. What is the difference between first aid station and first aid room?

First aid station and first aid room

F.Aid station is a designated place in a mine where a few essential items of first aid (stretcher, blankets, splints, triangular bandages, and a F.Aid box containing sterilised cotton, dressing, roller bandages, antiseptic, tourniquet, etc.) are kept in a box.

A mine has several F.Aid stations above ground, in opencast workings and belowground.

F.Aid station is kept under charge of a designated person in every shift who works nearby. In case of an injury, he comes to the F.Aid station and gives F.Aid to the injured person.

F.Aid room is a large room (atleast $10m^2$) on surface of the mine. It is a sort of a mini-dispensary (it has a large table, benches; piped water supply, sink, washing soap, towel; dressings, cotton wool, bandages, antiseptic lotion, stretcher, blankets, triangular bandages; stove, thermometer, ATS, syringe etc.). If there is no hospital within 3km, it is provided with two well equipped beds also.

F.Aid room is under charge of a doctor and in every shift, it is manned by a nurse and a dresser/compounder.

A mine has only one first aid room.

Q. 74. What is methane layering? Why is it dangerous?

Methane layering

Formation of fairly stable layers of methane at the roof level, due to low specific gravity (0.553), is known as methane layering. Methane layers have been found to contain upto 40% CH_4 at the roof level, while CH_4 30cm below the roof was only 1%.

Dangers

- High concentration of CH_4 in methane layer cannot be detected by FSL. The concentration falls rapidly a few centimetres below the roof.
- Methane layer is capable of slowly moving along the roof of a rising roadway even against the direction of air, and it may be connected to a dangerously high volume of gas accumulated at a far distance. It may act as a fuse to cause an explosion.
- In the event of a roof fall, CH_4 of the layer may come down, mix with air and form an explosive CH_4-air mixture.
- Methane layers have been responsible for some explosions in various countries.

Q. 75. What is the difference between Anemometer and Velometer?

Both are used for measuring volume of air flowing in a mine roadway. But,

1. Anemometer measures distance travelled by air in a given time. Velometer measures the air velocity at any point.
2. Anemometer is traversed along section of the roadway to get a correct reading. With velometer, spot readings are taken at various spots and averaged.
3. Anemometer consists of a small fan, vanes of which are set an angle of $40\text{-}45^0$ to direction of air flow and are propelled by the moving air. Vanes are rotated at a speed proportionate to the air velocity.

   Velometer consists of a double pivoted spring balanced aluminium vane housed in an expanding duct. Kinetic energy of the air current is converted to static pressure which moves the vane whose angle gives velocity of air.
4. Anemometer reading is to be corrected as per the chart supplied with each individual anemometer. Velometer does not need any such correction.

Q. 76. What is shown on overman's hand plan?

Overman's hand plan

It is a tracing of the u.g. plan (scale 1:2000) showing the following special features :

1. Outline of area under charge of the overman.
2. Projection lines of workings, with size of pillars/galleries and proposed sites of isolation stoppings and air crossings.
3. Sequence of pillar extraction in depillaring districts.
4. Conditions imposed by DGMS.
5. Ventilation–intake and return airways, stoppings/doors/air crossings.
6. Haulage and travelling roadways, emergency exits.

7. Telephone, F.Aid and fire stations.
8. Known or apprehended dangers like:
   - Faults, dykes, boreholes
   - Restricted workings
   - Water danger warning lines
   - Goaves
   - Subsidence areas
   - Staple pits, drifts
   - Coal barriers

Q. 77 Define : Permitted explosives
Slurry explosives
Emulsion explosives
Bulk explosives

Permitted explosives are explosives of a type permitted by DGMS for use in u.g. coal mines. They are manufactured by such firm and of such type as has been notified by the DGMS in the gazette. Permitted explosives of classes P1, P3 & P5 are manufactured in India.

Slurry explosives. A 'slurry' is a mixture of oxidisers (such as sodium nitrate and ammonium nitrate), a fuel sensitizer and water (about 25%). The mixture is thickened by guar gum and cross linking agent is added to avoid segregation of these solids. Slurries are water resistant. Permitted slurries are also manufactured.

Emulsion explosives are most modern efficient mining explosives. In emulsion explosives, the oxidiser (Ammonium Nitrate in fine particle size) and fuel oil both are in liquid form. Normally oil and water do not mix. With the help of an emulsifying agent, an intimate mixture of water (containing oxidiser – ammonium nitrate) and fuel oil is achieved and hence the name. Because of very fine particle size and intimate contact of oxidiser and fuel, the explosive reaction is very high. They are excellent explosives – superior to slurries.

Bulk explosives are explosives which can be delivered into the drill hole by a pump truck or a mechanised delivery system. They are used in opencast mines.

Q. 78. What can cause misfire underground?

One or more of the following can cause misfire u.g. :
- Faulty connection
- Detonators left off un-connected
- Detonator lead wires damaged
- Defect in shotfiring cable
- Exploder unable to give adequate firing current
- Number of holes in a circuit more than the exploder can fire
- Defective detonator.

Q. 79. Water spraying is done upto what distance from the face?
upto 90m from the face.

Q. 80. Why spot levels are shown on mine plan?

Spot levels help in :
- Assessing danger of inundation
- Dewatering
- Co-relating seams in adjoining workings
- Verifying parting between two contiguous seams/sections
- Rescue work.

Q. 81. What is the difference between duties and responsibilities of overman and mining sirdar?

Overman and Mining Sirdar

1. Mining sirdar is responsible for :
   (a) Safety of men under his charge.
   (b) Checking roof and sides and setting supports.

   Overman is responsible for :
   (a) Checking safe operation of ventilation devices and safe conditions in haulage roadways (tracks, safety devices, ropes, pulleys, preventing unauthorised travel etc.).
   (b) Ensuring adequate supply of materials (timber, roof bolts, brattice, etc.).
2. In case of apprehended danger, mining sirdar withdraws men to safe place, fences off the dangerous place and

informs overman, but for removal of danger, mining sirdar has to take directions from the overman.

3. In case of accident, both are required to inspect immediately, rescue the trapped men and give first-aid, but overman has added responsibility of finding out details as to the cause of accident.
4. Overman oversees work of mining sirdar and shot firers. An overman may have more than one mining sirdar district under his charge.

Q.82. (a) What should be the minimum distance between two shafts?
13.5m

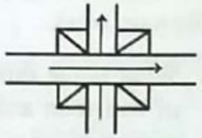
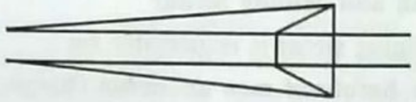
(b) What is the maximum permissible height and width of a gallery?

As per the Regulations, gallery height should be not more than 3m, and gallery width not more than 4.8m. But, for mechanised districts like continuous miner districts, DGMS can permit width upto 5.6m.

(c) What is the symbol of intake airway and what is its colour?

Intake airway is shown by a green arrow indicating direction of air.

(d) What is the symbol of –

- Explosion proof air crossing  black
- Incline  black

(e) What is the minimum thickness of rib?

While depillaring, the minimum thickness of rib left against the goaf is kept 2m. But, on the return,it is thinned down as much as possible, and if that is not possible, it is blasted down.

(f) What should be the minimum oxygen in a u.g. mine?
19%

(g) What is the gap between two wallsof an explosion proof stopping?
4.5m

Q. 83. What is meant by SSR?

Systematic Support Rules (SSR) are roof and sides support rules made by manager as per the Regulations and approved by Regional Inspector. Manager hands over copies of SSR to all supervising officials and arranges to post copies at conspicuous places in the district.

Q. 84. State precautions to be taken to prevent side-fall accidents in opencast mines?

Precautions to prevent side-fall accidents in O/C mines

1. Height and width of benches shall be as per the regulations.
2. Stability of benches shall be maintained.
3. Face shall not be parallel to a fault.
4. A garland drain shall be made around the quarry to prevent entry of rain water into the mine.
5. During and after heavy rains, mining sirdar/overman and other officials shall inspect faces, sides and ump. Faces stable in dry season may become unstable due to effect of rain water.
6. Under-cutting shall not be permitted.
7. Before engaging workmen on or near quarry side, loose material and overhangs shall be dressed down.
8. Blasting shall be regulated to avoid back-breaks.
9. Workmen shall not be engaged for work on a quarry side without safety belts.

Q. 85 What is : Sub-station
Reserve station
First aid station

Sub-station is a place in the mine where transformers and electrical switchgear are installed.

Reserve station is an authorised place in the district where explosives and detonator boxes are kept during the shift.

First aid station is a place in the mine fixed by the manager for storing F.Aid equipment and for rendering F.Aid to the injured.

Q. 86. Where is reserve station located?

Reserve station is fixed by the manager. It is located at an isolated place—

- Not frequented by men
- Away from a haulage roadway
- Which has no electric cable or switch within 90m
- Where there are no overhangs or under-cuts, and the roof and sides are secure.

Q. 87. Define : Igneous rock
Outcrop

Igneous rock is a rock formed by solidification of molten material (magma) from the earth's interior. It is very hard, compact, impervious and heavy. Example: Granite, Mica peridotite, Dolerite.

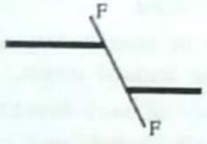
Outcrop of any rock stratum or coal seam is that part of it which is exposed at the surface.

Q. 88. What is the diameter of NX hole?

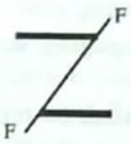
Diameter of NX hole is 75mm.

Note : NX = 75mm, BX = 60mm, AX = 47mm, EX = 38mm

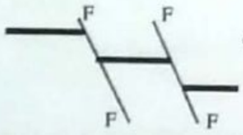
Q. 89. Find out which type of fault is shown in sketches A-E.



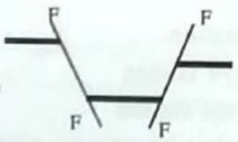
(a) Normal fault,



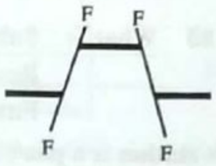
(b) Reverse Fault



(c) Step fault



(d) Trough fault



(e) Horst fault

Q. 90 What is hydraulic gradient in stowing?

Hydraulic gradient of a stowing installation is the ratio of level difference between the mixing cone and the place stowed to 'standard' length of pipe.

$$\text{That is, hydraulic gradient} = \frac{\text{Head of water from mixing cone to place stowed}}{\textit{Standard length} \text{ of pipe range}}$$

Standard length of pipe range is obtained by converting pipe lengths of different diameters to lengths of same diameter and adding for each bend a length of straight pipe of equivalent resistance.

For good stowing, hydraulic gradient should be 1 in 7 or steeper.

Q. 91. What is hydraulic profile of stowing range?

Hydraulic profile is a graph in which standard length of parts of the pipe range of different diameters is plotted against the head available.

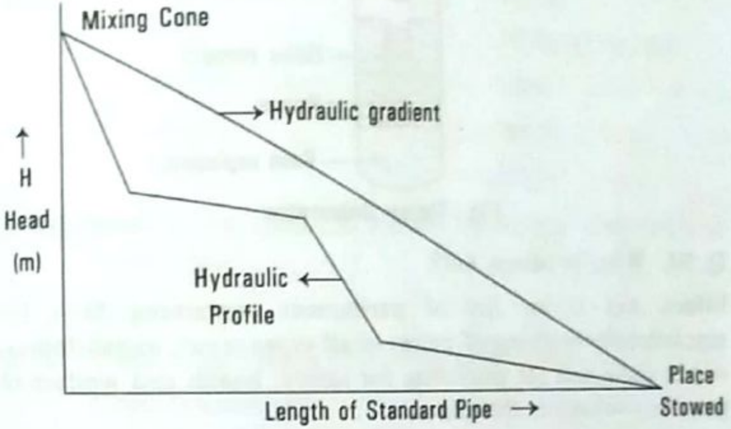


Fig : **Hydraulic profile of stowing range**

Stowing pipe range dia is progressively reduced from mixing cone to the face. 'Standard length' takes into consideration variations in pipe dia and the bends. Lenghts of different diameters are converted into equivalent length of similar dia using a standard formula.

Also, for every bend, length of standard dia pipe of equivalent resistance is added.

Hydraulic profile shows whether the sand-water mixture would flow at a constant speed throughout.

Q. 92. Define 6 x 19 stranded rope.

6 x 19 stranded rope means a steel rope made up of 6 strands, each of which has 19 wires. Such a rope is used for winding.

Q. 93. Make a sketch of delay detonator and label it.

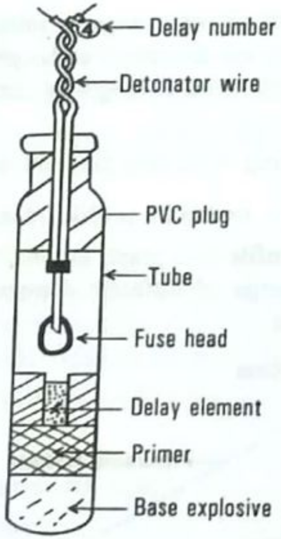


Fig : **Delay detonator**

Q. 94. What is Mines Act?

Mines Act is an Act of parliament containing laws for regulation for working of mines of all types (coal, metalliferous, oil) in India and for providing for safety, health and welfare of persons working in the mines.

Coal Mines Regulations, Mines Rules, Rescue Rules, Vocational Training Rules, Pit head Bath Rules and Crèche Rules— all have been framed under the Mines Act.

Q. 95. What do you understand by 1 in 16?

1 in 16 means a rise or fall of 1m in 16m horizontal distance. It is a method of indicating inclination.

Q. 96. What will you do at 1.25% gas in the mine?

Actions on detecting 1.25% CH_4 underground

- Cut off power to the district.
- Withdraw men to intake air.
- Stop all blasting work on the return side.
- Fence-off the place.
- Inform higher official.

- Search for the cause and improve ventilation.
- Do not permit men to enter or to switch on the power until the gas has been cleared as revealed by a thorough inspection.
- Write a report in the B.P.book giving details of percent, gas, place, time, cause, action taken, latest status.

Q. 97. Name the harmful gases found in mines and their permissible limits in ppm.

Harmful Gases	Permissible Limit
CO	50ppm
CO_2	5000ppm (0.5%)
Nitrous fumes	5ppm
H_2S	7ppm
SO_2	7ppm

Q. 98. What is the chemical symbol of the gas with smell of rotten eggs?

H_2S

Q. 99. What is the length of dusting zone?

150m (maximum)

Q. 100. At what distance is a relieving hole drilled for relieving a misfire?

30cm (minimum)

Q. 101. (a) Name the thickest coal seam in India.

Jhingurda Top seam in NCL—140m thick.

(b) What is the wet bulb temperature above which the air velocity should be atleast 1m/s?

30.5^0C

Q. 102. Under which regulation is an overman appointed?

Reg.34 of CMR 1957

Q. 103 Under which regulation is mining sirdar appointed?

Reg.113 of CMR 1957

Q. 104 In which forms are attendance registers maintained?

Attendance registers are maintained in Forms C, D, E of Rule 78 of the Mines Rules :

Form C—for persons employed belowground
Form D—for persons employed in opencast workings
Form E—for persons employed above ground.

Q. 105. Which fire extinguisher will you use for electric fire: CO_2 type or foam type?

CO_2 type

Q. 106. Coal of which coalfield has highest sulphur content?

North Eastern Coalfield

Q. 107. Which fuel is used in GL-7 safety lamps?

Esso solvent BP- 1425 or its equivalent or motor spirit (petrol)

Q. 108. Two galleries are approaching each other. What steps will you take?

Steps to be taken when 2 galleries are about to join:

- The Overman shall inform the Mining Sirdar and the Shotfirer.
- He will also order stoppage of one of the faces. Mining Sirdar will stop one face and fence it.
- The Overman will discuss with Mining Sirdar and Shotfirer to decide places where sentries are to be posted.
- If the Shotfirer does not have required number of assistants, the Overman will provide him persons from face workers for the purpose of guarding.
- Shotfirer will post the sentries, complete preparation at the face, check for gas and shouting warnings, retreat to the place of safety with his assistants, and after giving further warnings, shall blast the face.
- Shotfirer shall inspect the face. If all is OK, he shall inform the Mining Sirdar who will get the face dressed and supported and then intimate the Shotfirer.
- Shotfirer will withdraw the sentries and permit men to enter for work.

This process will be repeated until the two galleries join.

Q. 109. What will be your contribution to improve production from LHDs and SDLs?

Improving production from LHDs/ SDLs

- Timely preparation of ample coal so that the machine does not remain idle.
- Leaving balance prepared coal for the next shift.
- Ensure that the operator does not overload the bucket or the pony belt conveyor/ chain conveyor.
- Keep the galleries clean for smooth movement of machines.
- Arrange good ventilation, and good dust suppression by water spraying.
- SDLs/LHDs to be numbered and operator gangs fixed machine-wise to prevent loss of time in machine allotment at the beginning of the shift. The operator will get used to his machine and take better care.
- Arrange floating manpower to take care of absenteeism.
- Attend to the breakdowns promptly.

Q. 110. What are the provisions about OB dumps?

Provisions about OB dumps

1. The dump shall be formed on stable ground—if floor is slippery, it shall be roughed up by blasting. Soft material like soil shall not be dumped at the floor level.
2. Slope of the dump face shall be determined by the natural angle of repose, but it shall in no case exceed 37.5°.
3. Dump shall not be retained by artificial means at an angle greater than the angle of repose.
4. If dump height exceeds 30m, it shall be benched. Bench height shall not be more than 30m.
5. Drainage of dump and surrounding area shall be arranged properly so that water flows away from the dump.
6. Toe of the dump shall not be permitted to approach railway, public road, building or other structure closer than a distance equal to the dump height.

7. A fence shall be provided near the toe of the dump to prevent persons from approaching it.
8. Overman will inspect the dump atleast twice during the shift. During and after heavy rains, he shall inspect the dump jointly with the dumper operators.
9. Dump shall not be formed directly below and near an over-head line.
10. Dumping area shall be provided with a berm of height 1m or half the wheel dia.
11. Non- dumping area or unstable area shall be demarcated by dumping material to a height of 2m.

Q. 111. Why is the width of man-hole in haulage roadway kept not less than 0.75m or more than 1m?

Width of man-hole less than 0.75m will not permit easy entry. Width more than 1m may permit a tub entering into the man-hole and injure the person taking shelter there.

Q. 112. What is workmen inspector?

Workmen's Inspector is an employee so nominated by the manager in consultation with the main trade union to inspect the mine on behalf of the employees.

In every mine employing 500 or more persons, 3 persons are nominated as Workmen's Inspector—an overman, an electrical supervisor and a mechanical foreman.

As per recommendations of 9th Safety Conference, all mechanised mines and mines using HEMM, where 100 or more persons are employed, should also appoint workmen's inspector.

Such employees function as WI on two days in a week and do their normal work on rest of the days.

Q. 113. What is ventilation plan?

Ventilation Plan is one of the 4 basic plans to be kept at every u.g mine. It is a plan of mine workings showing the *system of ventilation* of the mine, and in particular—

i. general direction of air current.

ii. air measurement points.

iii. stoppings, ventilation doors, air crossings and regulators.

iv. fire stoppings.

v. room used for storing inflammable materials.

vi. position of fire fighting equipment.

vii. water dams.

viii. pumping, telephone and first-aid stations.

ix. haulage and travelling roadways.

This plan helps in proper maintenance of ventilation of the mine.

Q. 114. What is danger zone of blasting?

In opencast workings, an area falling within a radius of **500m** from place of firing is called **'danger zone'**. Blaster shall not charge or fire a shot unless a sufficient warning, by efficient signals or other means, approved by the manager, is given over the entire danger zone, and has ensured that all persons within the danger zone have taken proper shelter. All those who must remain within the danger zone at the time of blasting are required to take shelter in substantially built shelter.

Q. 115. What is the safety feature of cap lamp?

Cartridge type silver fuse between negative of battery terminal and the cable lead provides safety against excessive current in event of a short circuit. This fuse blows at **4amps**. As a current of **26amps** is required to create a spark of sufficient energy to ignite an explosive methane-air mixture, the fuse gives adequate margin of safety.

Q. 116. State precautions to prevent flyrock in opencast mine.

Precautions to prevent flyrock

1. Removing stones from the blast area before drilling.
2. Site of every hole to be marked by the overman after tape measurement taking care of weak planes, cracks and dis-continuities.
3. Ensuring drilling at correct places and to the correct depth.
4. Avoiding over-charging. Deck-charging where required.
5. Stemming length to be not less than hole burden.

6. Ensuring that boulders do not fall into the holes. They act as missiles and are thrown over large distances.
7. Choosing inter-row delay correctly. Too long a delay causes inadequate burden, and too small a delay results in upward movement of rock/flyrock.
8. Proper training of staff engaged in drilling/blasting.

Q. 117. Describe how you will give first aid to a person who has received injury in backbone?

F.Aid for injury in backbone

1. Inform attendance clerk to keep an ambulance ready.
2. Place pads between the injured person's ankles, knees and thighs. Apply a figure of 8 bandage around ankles and feet (knot to be tied under soles). Apply broad bandage around knees and thighs.
3. Put him on a hard level ground.
4. Treat for shock (re-assure the person, loosen clothing about neck/chest/waist, and cover him up with a blanket).
5. Prepare a stretcher. Place a folded blanket and then blanket the stretcher.
6. Turn the stretcher on its side, close to injured person's body. Place 2 rolled blankets—one across the front of his shoulders and the other across the front of his hips. Carefully turn the stretcher and the victim as one into correct position for carrying. Turning of victim with face injuries may be assisted by the bearer pulling on the edge of blanket under him. Comfortably support the head, cover up the blanket and secure him to the stretcher.
7. Arrange transport to surface in face down position, with a responsible escort.

Q. 118. What are the statutory provisions for benches in opencast mines?

1. **Manual quarry**

   Soft OB : Sides shall be benched- bench height not exceeding 1.5m, width not less than the height.

   Coal : Bench height not exceeding 3m, width not less than the height.

   Hard OB : Sides to be adequately benched to prevent danger of side fall.

2. **Mechanised O/C**

   Bench height : Not to exceed digging height of the excavator or loading machine.

   Bench width : Not less than—

   i. bench height, or
   ii. width of widest machine + 2m, or
   iii. 3 times width of the dumper,

   widest of the above

Q. 119. Jot down essentials of standard of ventilation of underground mine.

Standard of Ventilation

▪ Air in the last ventilation connection of district	Atleast 6m^3/min per person employed in the largest shift
▪ At every place where persons are required to work or pass	O_2 not less than 19% CO_2 not more than 0.5%
▪ CH_4 in district return air	Not more than 0.75%
CH_4 at any place in the mine	Not more than 1.25%
▪ Wet bulb temperature at working place	Not more than 33.5^{0}C
Where wet bulb exceeds 1m/s 30.5^{0}C	Air velocity not less than
▪ To check compliance	Air samples & measurements to be done atleast once in every 30 days
▪ Mine to be ventilated by	Mechanical ventilator

Q. 120. What is fire damp?

Fire damp is a mixture of inflammable gases given out from coal seam or surrounding strata. It is mainly methane with traces of nitrogen and CO_2.

Q. 121. Why is special attention paid to support of freshly exposed roof?

Particular attention is paid to support of freshly exposed roof because about 70% of fatal accidents occur in the freshly exposed roof, i.e. within 10m of the face.

Q. 122. How will you relieve a misfire?

Relieving a misfire

1. Fence entries to the place.
2. Attempt to fire the shot after correcting defect in cable/connections.
3. If it does not blast, get relieving hole drilled in own presence atleast 30cm from the misfired hole, charge & blast it.
4. Search for misfired cartridges/detonators in the blasted material without using tools.
5. If explosives/detonator is not found, load blasted material in a marked tub and search on surface.
6. Deposit traced explosives and detonator with the magazine clerk.
7. If misfired shot is not relieved before end of the shift, inform the incoming shotfirer.
8. Write a report in the misfire report book.

Q. 123. At what interval should the mining sirdar inspect the district?

In first 2 hours of the shift, and then as many times as necessary for safety but atleast once in every 4 hours.

Q. 124. In a district where working height exceeds 3m, what extra is required in respect of roof testing/support?

Where height exceeds 3m, provide at convenient places in the district :

(a) Wooden bunton or pole, of sufficient length to enable all parts of roof to be tested standing on the floor.

(b) A ladder of suitable length.

Q. 125. There has been an accident in your district. What steps will a mining sirdar of the district take?

As soon as an accident occurs, the mining sirdar shall :

1. Reach the spot promptly.
2. Rescue the injured, give him first-aid and arrange to transport him to the hospital.
3. Withdraw other persons from the place to prevent danger.
4. Inform the overman and the attendance clerk.
5. In case of serious/fatal accident, fence off the site of accident. Leave it un-disturbed/un-altered.

Q. 126. Define stook and split.

Stook. In a depillaring district, the pillar formed during development is divided in two to four parts depending on its size. These small parts are known as stooks. Stooks are then extracted one-by-one.

Split. A gallery driven in a coal pillar for diving it in 2 parts is called a split gallery or split.

Q. 127. What is a diagonal line of extraction and step-diagonal line of extraction?

Diagonal line of extraction is a slanting line of extraction making an angle of 45^0 with direction of dip of the seam. It is the most adopted extraction line because it is a long line providing a number of faces and better safety. Every stook under extraction has an un-worked stook by the side for support. Depending upon experience, any angle other than 45^0 may also be chosen.

Step- diagonal line of extraction. In this type, there is one solid stook between two stooks under extraction. The solid stook provides support. Hence, it is used where the roof is weak. Step-diagonal line can also be so arranged as to have 2 solid stooks between 2 stooks under extraction.

Q. 128. Smoke is coming from the goaf. What will you do?

1. Inform immediately :
    - Other districts
    - Surface, particularly the manager
    - Senior official present u.g.
2. Withdraw all persons, other than those required for dealing with the fire, to the surface via intake roadways and downcast shaft under supervision of mining sirdar.
3. Act calmly. Do not create panic.

4. Where work of dealing with the fire or sealing is in progress, arrange—
   - Proper ventilation.
   - Constant checks for gas with FSL, birds or approved detector.
   - Two smoke helmets nearby.
   - Constant supervision.

Q. 129. Smoke is coming out of a haulage engine room in a gassy seam of Deg.III. What will you do?

1. Cut off power of haulage and the district.
2. Withdraw men from return side of haulage.
3. Promptly attempt to quench fire with help of rescue trained persons available in the district.
4. Send men to get more fire extinguishers.
5. Inform :
   - The surface/manager
   - Other district mining siradars/overmen.
6. Take care of safety of men engaged in fire fighting.

Q. 130. In solid blasting, why delay interval between the first and last holes of a round is limited to 150ms.

This is done to eliminate possibility of methane released by the earlier shots in a round, being ignited by later shots.

Q. 131. Why is it not desirable to draw samples from behind a fire stopping when barometric pressure is rising?

When barometric pressure is rising, fresh air leaks into the fire area and dilutes air near the stopping. Sample drawn will therefore not be representative. Sample should be taken at the time of falling barometric pressure.

Q. 132. What is the maximum number of shots that a shotfirer can be authorised to fire in a shift?

Deg. II/Deg. III seam or fiery seam :	40 with single shot exploder 80 with multi-shot exploder
Deg.I seam	50 with single shot exploder 100 with multi-shot exploder
O/C mines	60 with single shot exploder 120 with multi-shot exploder

Q. 133. If there is a fire in the mine, what information will you give to the manager?

- Where and what has happened.
- What actions I intend to take.
- Assistance needed.

Q. 134. (i) What is the composition of white metal used in rope cappel?

(ii) Volatile matter in coal dust is 32%. What percent of incombustible matter is required to render it safe?

(iii) Which instrument is used to measure respirable coal dust?

(iv) What type of ropes are used as guide ropes?

(v) By which instrument is levelling done in hilly area?

(vi) Which gas is produced in cap lamp? At what voltage is cap lamp charged?

(vii) What is the thickness of ventilation stopping?

(i) 5% tin, 15% antimony, 80% lead

(ii) 85%

(iii) Approved gravimetric dust sampler or personal dust sampler

(iv) Locked coil ropes

(v) Tacheometer

(vi) Hydrogen; 4.8v D.C.

(vii) 38cm

Q. 135. (i) What are the dimensions of lid of a prop?

(ii) In which direction is anemometer placed?

(iii) Which instrument is used to check centre line in modern drift drivage?

(iv) What is the maximum permissible length of trailing cable in B & P workings?

(v) At what frequency is air in a mine measured?

(vi) 4 x 550 powered support. What does it mean?

(i) Width not more than dia. of prop, length not less than 50cm, thickness not less than 8cm

(ii) Anemometer is held facing the current of air and at right angles to it

(iii) Laser

(iv) Normally 90m in B & P workings, but, 250m when shuttle cars, LHDs etc. are used

(v) Atleast once in 30 days

(vi) 4 × 550 powered support means a 4 legged chock shield support which will yield at 550t load

Q. 136. (i) Permissible content of CO in a mine is 50ppm. Express it in percentage?

(ii) Why is CO highly dangerous?

(iii) Calculate the number of tubs in endless rope haulage to deal with 1200t in 6 hours hauling time from a roadway 1km long if the speed of tubs is 4km/hr.

(iv) Name 3 machines used in mechanised longwall face.

(i) 1ppm = 0.0001%

50ppm = 0.0050%

(ii) CO is highly dangerous because its affinity for haemoglobin of blood is nearly 300 times that of oxygen. CO combines with haemoglobin to form carboxy- haemoglobin. Even a small percentage of CO reduces oxygen carrying capacity of the blood in permanent way. Thus, its effect is cumulative. Further, a man affected by CO gives life like appearance, and by the time he realises to have been affected by CO, it is too late.

(iii) Coal per hour = 1200/6 = 200t on 4km of rope

Coal on rope 1km = 200/4 = 50t = 50 tubs

No. of empties = 50

Therefore, total number of tubs in the endless rope haulage = 50+50= 100

(v) Double ended ranging drum shearer (DERD), Armoured flexible conveyor (AFC), Stage loader

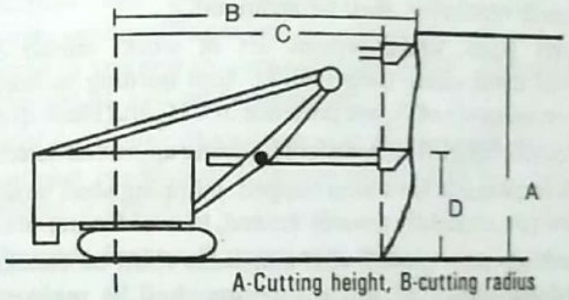
Q. 137. (a) How many voltages are used in the mine underground?

(b) Draw a figure to show cutting height, cutting radius, dumping height and dumping radius of a shovel.

(c) Two adjacent sides AB and BC of a regular polygon have azimuth 40^0 and 102^0 respectively. Find the included angle of the polygon.

(a) 3300 V for main pumps, 550 V for CCM, haulages, fans etc.; 125 V for drill; 1100 V for longwall face equipment like shearer, AFC, dintheader

(b) Operating parameters of shovel are shown in the sketch.



A-Cutting height, B-cutting radius
C-dumping radius, D-dumping height

Fig. **Operating parameters of shovel**

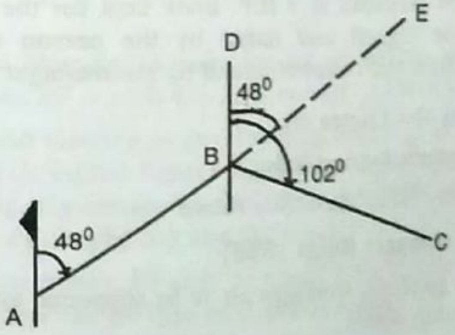


Fig. **Azimuth of sides of a polygon**

(c) $\angle$ DBE= 48^0

$\angle$ EBC = $102^0 - 48^0 = 54^0$

Included $\angle$ABC of polygon = $180^0 - \angle$EBC
= $180^0 - 54^0 = 126^0$

Q. 138. An abandoned water logged gallery is proposed to be restarted. Describe the precautions to be taken during dewatering and reopening.

Restarting abandoned water logged gallery

Abandoned gallery shall be approached from one of the existing connections and dewatering done directly by pumps of adequate capacity.

Precautions during dewatering/reopening

- Work shall be under constant supervision of an overman.
- Only approved safety lamps shall be used.
- Adequate ventilation shall be arranged.
- At every place, where persons are at work, atleast one approved flame safety lamp shall be kept burning to keep a watch on adequacy of O_2 and presence of CH_4 and black damp.
- Frequent checks shall be made for H_2S using approved detector.
- If air is suspected to have been trapped, pumping shall be done at a slow rate, especially towards the end, to avoid water blast.
- As workings are exposed, roof and sides shall be checked, dressed and supported, rotten supports shall be replaced.
- The first inspection of dewatered workings shall be done using approved flame safety lamp. Results of inspection shall be recorded in a B.P. book kept for the purpose. It shall be signed and dated by the person making the inspection and counter-signed by the manager.

Q. 139. Write short notes on :

Systematic Support Rules

Powder Factor, Detonator Factor

Systematic Support Rules (SSR)

As per the regulations, workings are to be supported systematically in the following places :

- Where splitting of pillars or depillaring is going on
- In every longwall working
- In every development working within 10m of face and every junction of roadways immediately outbye of a development face
- In every working in a disturbed or crushed ground, for example : fault zone
- At other places where the Regional Inspector may so direct.

Systematic Support Rules are framed by the manager on the basis of RMR of roof strata and enforced after approval by the Regional Inspector.

The rules indicate types of supports, their specifications, distance between supports in a row/between rows, distance of first support or sand pack from the face etc.

Manager hands over copies of SSRs to supervising officials. Copies are also displayed in the district. Manager and supervising officials are responsible to ensure that no part of the mine is worked in contravention of SSR. Additional supports are erected as and when required.

SSR take care of shifting roof stresses and they ensure uniform support resistance. Chances of mistakes are reduced and better safety is ensured.

Powder factor & detonator factor

Powder factor (PF) means tonnes of coal obtained per kg of explosives used for blasting.

Detonator factor (DF) means tonnes of coal obtained per detonator used.

If in solid blasting 14 holes loaded with 6.4kg explosives give 15t of coal, PF = 15/6.4 = 2.35 and DF = 15/14 = 1.1

PF for solid blasting in development workings maybe 2-2.5 and DF, 1.1-1.3; higher figures for thicker seams and soft coals. In depillaring, figures are higher—PF 4.5-5, DF 1.4-1.5. in pre-cut coal face PF maybe 5-8 and DF 1.8-2.

In opencast mines, PF may be about $2.3m^3/kg$ for medium hard rocks. It depends on type of explosive also.

Q. 140. Explain solid blasting. What are the essential conditions for safety?

Solid blasting

It is a technique of full face blasting without pre-cutting by coal cutting machine.

Holes are drilled in a **pre-decided fashion** and blasted in a **designed sequence** using **P5 explosives** with **non-incendive delay detonators.** The cut holes (wedge cut or fan cut) create the **initial free face** and holes of each delay create **free face for subsequent holes.**

Extra cooling agent in P5 explosives brings down the temperature of expanding gases to a safe limit and prevents ignition under adverse conditions. **Non-incendive delay detonators** eliminate danger of gas/coal dust explosion and roof/side damage by vibration.

Essential conditions for safety

1. P5 explosives, non-incendive delay detonators.
2. Pattern fixed by manager,
   - Delay between first and last hole not more than **150ms.**
   - Delay between holes of two consecutive delays not more than **60ms.**
   - Distance between holes of two consecutive delays not more than **60cm.**
   - Maximum charge per hole 1kg for Deg.I seam, 0.565kg for Deg.II seam.
3. Air atleast **284m^3/min** in **last ventilation connection** in Deg.I mine, and within **4.5m of the face** in Deg.II mine.
4. Check for CH_4 with approved methanometers upto 20m from the face of blasting. No blasting if CH_4 exceeds **0.1%** in Deg.I and **0.5%** in Deg.II mine.
5. Water spraying upto **90m** from the face.
6. Shots to be **inversely initiated.**
7. No solid blasting within **60m** of a geological disturbance.

Q. 141. Explain spontaneous heating of coal.

Spontaneous heating

Spontaneous heating of coal is the process of self heating of coal resulting eventually in its ignition without application of external heat.

When coal is exposed to air, it absorbs oxygen and undergoes oxidation even at normal atmospheric temperature. In this process, CO, CO_2 and water vapour are formed and some heat is evolved. But the heat is not perceptible because it is carried away by the air. If the conditions are such that rate of dissipation is slow compared to the evolution of heat, there is a gradual build-up of heat and slow rise in temperature of coal. At the raised temperature, oxidation is slightly accelerated and some other fractions of coal become susceptible to oxidation. A stage is reached when temperature of coal reaches ignition point of coal and it catches fire. Thus, spontaneous heating changes to spontaneous combustion.

Note : In a mine caved goaf, fallen coal in old workings, and crushed pillars between intakes and returns often develop spontaneous heating.

As a precaution, depillaring is done in panel system and the panel is sealed off as soon as extraction is complete. Fallen coal is removed from old panels or they are kept isolated. Workings are inspected on idle days. CO is measured in the return of depillaring district once a week to detect spontaneous heating in early stages.

75-80% of fires in Indian mines occur due to spontaneous heating.

Q. 142. Define : (a) Factor of safety of winding rope
(b) True bearing of a line
(c) Break-even stripping ratio
(d) Cross measure drift
(e) Neutral line

Factor of safety of winding rope

For a winding rope, factor of safety means ratio between *breaking load* of the rope at any point and the maximum *static load* on it when the cage is at the lowest working point.

As per the regulations, factor of safety of winding rope shall not be less than 10 at any point of time, unless an exemption is granted by the Chief Inspector.

True bearing of a line

Bearing of a line is the horizontal angle which it makes with some reference direction or *meridian.*

True bearing of a line is the horizontal angle which the line makes with reference to the true north or geographic meridian.

Break-even stripping ratio

Stripping ratio denotes the amount of OB in cubic metres required to be removed for obtaining 1t tonne of coal.

Stripping ratio increases with depth. Stripping ratio at which the 'total' cost per tonne of coal (including cost of reclamation) equals its net sale value, is known as 'break-even stripping ratio'.

Cross measure drift

An underground roadway from coal seam to an upper or lower seam is known as cross measure drift.

Neutral line

A booster fan is generally installed on the return side of a split leaving the intake free for haulage. When the fan is installed, water gauge on the return side of the split increases in relation to that on the intake side. There is some position in the return where, after installation of the fan, pressure in the return airway is equal to pressure in the intake airway. This position is known as the neutral line.

Neutral line is the best position for installation of booster fan. (If the fan is placed too far inbye of neutral line, re-circulation will occur. If it is placed too far outbye of the neutral line, a high pressure difference between intake and return will cause excessive leakage).

Q. 143. What is meant by angle of draw?

Angle of draw is the angle of inclination from the vertical of the line connecting the edge of workings u.g. and the edge of the maximum subsidence area on surface.

It is used to determine extent of subsidence trough at the surface in reference to the extraction perimeter u.g.

Q. 144. On what does the inflammability of coal dust depend? What are the limits of inflammability of firedamp?

Factors influencing inflammability of coal dust

1. Volatile matter content
2. Fineness of coal dust
3. Dustiness of mine workings
4. % of incombustible matter
5. % of moisture
6. % of firedamp in mine air
7. Nature and intensity of ignition source
8. Age of coal dust
9. Oxygen concentration
10. Turbulence
11. Surrounding conditions

Limits of inflammability of firedamp

Lower limit 5.4%, upper limit 14.8%

Q. 145. Describe : Shaft guides
Detaching hook
Stop block
Runaway switch.

Shaft guides

Guides are used in mine shafts to control swing of cages. They may be rigid guides or rope guides. Rigid guides are lengths of rails fixed to buntons. Rope guides are fixed to headgear structure at the top and have cheese weights at the shaft bottom to give requisite tension. Weights ensure verticality and reduce swing during a wind.

Rope guides are preferred as they are cheap and easy to maintain. The cheese weights are kept exposed to permit regular examination.

A set of 4 ropes is usually required for each cage although some shallow shafts have 2 or 3 per cage.

Detaching hook

Note : See the chapter on winding.

Stop block

Stop block consists of a wooden beam or block lying across the rails, pivoted at one end and held against a pivoted side block at the other.

Stop block is provided (a) at the top of every haulage plane (i.e. on landings) to arrest tubs

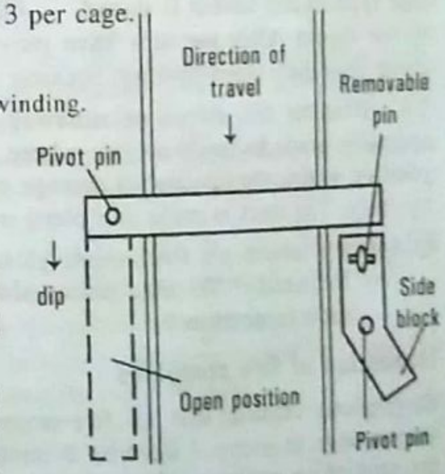


Fig : **Stop block**

from running down the incline uncontrolled, (b) on every sloping roadway or tramming level bringing loads to the haulage roadway.

When the train is coupled and attached to the rope, the small block is knocked out, and the tubs push the large block forward. For added safety, a pin is put through the small block and into the frame below when the block is in the holding position.

Note : For simplifying the sketch, sleepers have not been shown. Both the pivot pins are actually fixed in large sleepers fixed on either side of the track and extending over 3 track sleepers. The long sleepers are attached to the track sleepers by strong through and through bolts.

Runaway switch

Runaway switch is a safety device placed at the upper end (the brow) of an inclined haulage road as emergency stop when the ordinary means of control of tubs fail. It is provided below the first stop-block at a distance greater than the length of a set of tubs (but the distance not exceeding the length of a set of tubs by more than 10m).

One type of the switch is shown in the figure After the tubs have moved up, the switch blades come into their open position because of spring action.

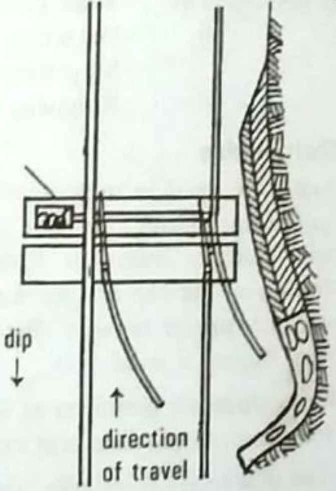


Fig : **Runaway switch**

To withstand the thrust of runaway tubs, a proper inset is specially made in roadway side where bags filled with sand are piled up so that the tubs do not damage crossbar etc. in the haulage roadway. The inset is made at a place where there is no manhole.

Q. 146. By whom are fire stoppings to be inspected and how frequently? To what points should attention be paid in such inspections?

Inspection of fire stoppings

Regulations require that all fire-stoppings must be inspected atleast once in every 7 days by a competent person not below the rank of an overman. However, in case of stoppings in thick seams or in areas where strata movement is likely to take place in the vicinity of the stoppings, inspections should be carried out regularly daily.

Q. 147. What would you check while inspecting a fire stopping?

Points to be noted are –

(a) Cracks in and around the stopping. Cracks may be detected by soot marks on the plaster, or by a hissing sound. Checks should be made particularly in corners and around pipes, rails etc. fitted in the stopping.

(b) Looseness of plaster.

(c) Conditon of roadway sides & supports; any signs of spalling or weighting.

(d) Level of water in water seal reservoir. It may require replenishment specially in dry season.

(e) Whether sample pipe, check board etc. are O.K., whether the valves are properly closed.

(f) Any rise in temperature of the stopping; temperature of water flowing out of the water seal; any rise in temperature and humidity outside the stopping.

(g) Presence of blackdamp or CO at the stopping with flame safety lamp and bird.

(h) Any obstruction in the approach road to the stopping, any accumulation of water.

Note : 1. Overman inspecting the stopping must carry with him flame safety lamp, a cage containing birds and self rescuer, and should be accompanied by one assistant.

The assistant should keep at a reasonable distance behind the overman so that both are not affected by leakage of CO, if any, at the same time.

2. The overman should initial and date his initials himself (while he does so, he will get further opportunity of a closer look).

3. Inspection record should be kept stoppingwise.

4. A sample of air behind the stopping should be drawn and analysed at least once in every 30 days.

Q. 148. What is the difference between :

(a) Competent person and official

(b) Booster fan and auxiliary fan

(c) Temporary stopping and permanent stopping

Competent person and Official

Competent person in relation to any work or any machinery, plant or equipment, means a person who has attained the age of 20 years and who has been duly appointed in writing by the manager, as the person competent to supervise or perform that work, or to supervise the operation of that machinery, plant or equipment, and who is responsible for duties assigned to him.It includes a shotfirer.

Example : haulage engine khalasi, electrician, lamp room incharge, SDL operator, dumper operator.

Official means a person appointed in writing by owner, agent or manager to perform duties of supervision in a mine or part thereof. It includes mining sirdar, overman, under manager, assistant manager, ventilation officer, engineer, safety officer, overman, dust incharge, sampling incharge and surveyor.

Booster fan and auxiliary fan

Booster fan means a mechanical ventilator used belowground for boosting the whole current of air passing along the intake or return airway of the mine or ventilating district.

Auxiliary fan means a forcing or an exhausting fan used below-ground, only or mainly for ventilating one or more faces forming part of a ventilating district.

Q. 149. Tick the correct answer from the bracket :

(a) Mine entrance should be sited above HFL by atleast (1.45m, 2.5m, 1.5m).

(b) Quantity of air taken by an auxiliary fan should not exceed (1/2, 2/3, 1/3) of the quantity of air current from which the fan takes its supply.

(c) Cap lamp is (flame proof, intrinsically safe, none) apparatus.

(d) 16% of oxygen in mine air corresponds to nitrogen percentage (79.04, 69.07, 60.42).

(e) In B & P workings, heavy type stone dust barrier would be provided at a distance not less than (135m, 145m, 150m) from the face.

(a) 1.5m

(b) ½

(c) None

(d) 79.04

(e) 135m

Q. 150. Describe the precautions to be taken in underground while approaching an old water-logged working.

Precautions while approaching water-logged workings

1. If the water-logged workings are accessible, they shall be dewatered and examined before driving towards them. If they are not accessible, their distance shall be assessed from careful study of the plans and check survey of workings. For drivage within 60m, a definite plan of working shall be drawn up and approval of Regional Inspector obtained. Work shall proceed strictly as per this plan.
2. Height and width of gallery shall not exceed 2.4m. Atleast one borehole shall be maintained at the centre of face, sufficient flank holes on either side (and if necessary, boreholes above and below the workings) at interval not exceeding 5m. The holes shall be sufficiently close to each other to ensure that the advancing face will not accidentally hole into the waterlogged workings. All holes shall be maintained atleast 3m in advance of the face.
3. Work shall be done under constant supervision of an experienced under-manager or overman. He shall maintain a record showing actual height and width of gallery and length, direction, position of each borehole, with a note on all safety aspects.
4. A plan shall also be maintained showing the above details.
5. Other precautions : Maintenance of a safe exit route (well lighted, free from obstructions, with a raised travelling way and a rope railing); good ventilation, good lighting, good support; frequent checks for CH_4, H_2S and CO_2; adequate pumping arrangements; telephonic communication.
6. Any unusual seepage of water or smell of stinkdamp shall be taken as a danger signal.
7. All boreholes shall be done by safety boring machine. Final tapping shall be done under supervision of senior

officials, under cover of rescue brigade ensuring safety of all persons including those in connected workings. Self rescuers shall be kept available for emergency.

Q. 151. Where and at what intervals mine air samples are taken in case of Deg.II and Deg.III gassy mine?

1. In a gassy mine of Deg.II/Deg.III, samples of air are drawn in every ventilating district to determine percentage of CH_4 in the general body of air once in every 7 days. But—
   - (i) if any determination shows gas over 0.8%, samples shall be taken at intervals not exceeding 24hours for so long as gas exceeds this percentage and for next 7 days.
   - (ii) if the determinations show gas less than 0.6% *persistently for 30 days,* samples may be taken once in 30 days as long as gas does not exceed 0.6%.

Place. The samples are taken at points fixed by the manager, on intake side of the first working place and on return side of last working place in every ventilating district.

2. Other samples
   - (a) *For spontaneous heating* : Once in 30 days in the return airway of every depillaring district and every unisolated goaf to determine CO formed/O_2 absorbed ratio.
   - (b) *For ventilation standards* : Once in 30 days to ascertain compliance with standards of ventilation with respect to O_2, CH_4, CO_2 and noxious gases. Samples to be taken within 30m of the last working face and at the outbye end of the main return.

     These are used also to keep a check on degree of gassiness
   - (c) *Behind stoppings* : Once in 30 days, from behind stoppings built to isolate old workings or goaf on fire or spontaneous heating, to study atmospheric condition.

Q. 152. For what purpose are isolation stoppings constructed? What is the prescribed thickness of isolation stoppings?

Isolation stoppings

Isolation stoppings are constructed for :

(a) Forming panels where development has not been done in the panel system.

(b) Around depillaring districts.

(c) To seal off fire area.

(d) To isolate old/disused workings.

Thickness (brick in cement/lime mortar)

Deg.I & II	Stowing district	0.5m
	Caving district	1m (to be converted to explosion proof stoppings if CH_4 inside exceeds 2%)
Deg.III	Stowing district	1m
	Caving district	1-4.5-1m (explosion proof stopping)

Explosion proof stopping consists of two stoppings, each 1m thick, 4.5m apart and the intervening space is kept filled with sand or incombustible matter.

Foundation for every isolation stopping shall be 1m in coal, or 30cm in shale or 15cm in sandstone. Exposed face of the stopping and roof/floor/sides of gallery upto 1m on either side of stopping are to be plastered in sufficient thickness of lime or cement mortar (rounding off the joints at roof/floor/sides) to prevent leakage. Stopping is to be kept whitewashed and numbered.

This thickness is the minimum thickness at the roof level. In case gallery height exceeds 3m, thickness of stopping is increased by 15cm for every 3m height.

Q. 153. Explain crossing point temperature of coal.

Crossing point temperature of coal (CPT) is a measure of proneness of coal to spontaneous heating. Powdered coal is heated in a standard bath, allowing oxygen or air to pass over it at a specified rate. After some time, coal develops spontaneous heating due to which its temperature 'crosses' (i.e. exceeds) the temperature of the bath. This temperature is called crossing point temperature of coal.

Coals having a low crossing point temperature 120-140^{0}C (and high moisture over 5%) are considered 'highly susceptible' to spontaneous heating, coals of crossing point temperature 140-

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160^{0}C (and medium moisture 2-5%) are considered 'moderately susceptible' and those of above 160^{0}C (and low moisture <2%) 'poorly susceptible'.

Typical Jharia filed coals have CPT in the range of 160-170^{0}C and the Raniganj coals in the range of 120-130^{0}C.

Q. 154. (a) When should you use the self rescuer?

Self rescuer should be used immediately on first indication of a fire or explosion even when no smoke is visible. Waiting until the smoke is visible may prove fatal. CO is colourless and odourless, and could build up to a dangerous concentration before there is any sign of smoke.

(b) If the device begins to get hot, what should you do?

Do not remove the self rescuer. Try to escape out of foul air as quickly as possible.

(c) Can self rescuer be used for fire fighting?

No.

Q. 155. What essential actions should be taken before clearing debris of a roof fall?

1. Inspect carefully.
2. Stop haulage if fall is in haulage roadway.
3. Dress and support the lips to prevent the fall extending in length.
4. Establish ventilation.
5. Dress and erect temporary supports.

Q. 156. What is a yielding prop?

Yielding props are those that 'yield', i.e. decrease slightly in length when roof weight exceeds a pre-set load.

Q. 157. What is meant by outbye?

A direction towards the shaft or on intake side.

Q. 158. Give signs and symptoms of *lal munia* when under the influence of CO.

First—Blinking

Second—Gaping

Third—Swaying on perch

Fourth—Falling off perch with wings out-stretched.

Q. 159. For what purpose is laser scanner used in mining?

Laser scanners are modern survey instruments which are used for monitoring the stability of sides of opencast workings and slopes of OB dumps.

Q. 160. State composition of inhaled and exhaled air of human beings in normal atmosphere.

Inhaled air—N_2 79% O_2 21%

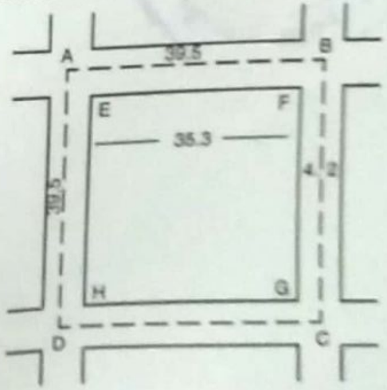
Exhaled air—N_2 79% O_2 17% CO_2 4%

Q. 161. Write the full form of : CHP, RCC, LHD, SDL, MART, RL.

CHP	Coal Handling Plant
RCC	Reinforced Cement Concrete
LHD	Load Haul Dumper
SDL	Side Discharge Loader
MART	Multi-Access Radio Telephone
RL	Reduced Level

Q. 162. A 2.5 thick seam at a depth of 250m has gallery width 4.2m. What will be the percentage extraction of coal during development.

At depth of 250, for 4.2m wide gallery, the prescribed minimum pillar size is 39.5m centre to centre.



Side of solid pillar = 39.5 – 4.2
= 35.3m

Assuming, full height extraction,

$$\text{Coal left in pillar} = \frac{35.3 \times 35.3}{39.5 \times 39.5} \times 100 = 79.9\%$$

Hence coal extracted in development = 100 – 79.9 = 20.1%

Q. 163. What is fly rock?

Fly rock is undesirable movement of blasted rock from hole area. It is uncontrolled scattering of blasted fragments from bench at random. It is a major cause of accidents in opencast mines.

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